California Academy of Sciences Integrated Pest Management Plan

Written in collaboration with Pestec

By: Michael Millican (Pestec),
Kristen Natoli (CAS),
Luis Agurto IV (Pestec)
and Kevin Manalili (CAS)

1. Introduction

This integrated pest management (IPM) plan was developed by the California Academy of Sciences in accordance with:

- the City and County of San Francisco IPM ordinance
- the California Academy of Sciences Pest Prevention Policy
- the LEED requirement for IPM in the certification of existing buildings.

All structural pest management will also adhere strictly to the standards set forth by EcoWise Certified and Green Shield Certified Integrated Pest Management certifications.

This is a comprehensive plan covering the entire Academy complex, and provides specific and general recommendations for the abatement and prevention of structural and landscape pest activity on-site.

The California Academy of Sciences is an ideal location to employ integrated pest management practices as all of the major stakeholders in building management have the utmost concern for human health and the environment. Pest management within LEED facilities must seek to "do no harm". Integrated pest management focuses on prevention of pest activity through sanitation recommendations, building repairs and habitat modifications. A chemical control selected from the San Francisco Department of the Environment Reduced Risk Pesticide List of materials may be employed only as a last resort; after all non-chemical avenues have been explored. The use of a chemical control is a decision that should be made in collaboration with building management stakeholders and an integrated pest management services provider.

This document describes in detail the IPM plan on-site at the California Academy of Sciences. It describes proposed methods of monitoring and detecting pest activity with an outline of recommended physical and chemical controls for specific pests. A service schedule for integrated pest management on-site is included along with a list of structural and operational changes that will facilitate the integrated pest management effort.

The appendixes contain pest fact sheets from Pestect and the text of both the Academy Pest Prevention Policy and the Academy Pesticide Safety Program.

2. Contact Information

Position	Name	Email	Phone	Responsibilities
Operations Director for California Academy of Sciences	Kevin Manalili	kmanalili@cakacadeny.org	415.379.5470; Fax: 415.379.5716	California Academy of Sciences IPM coordinator and administrator of the IPM plan
Pest Control Advisor for the California Academy of Sciences and liaison with San Francisco Department of the Environment	Kristen Natoli	KNatoli@calacademy.org	Work: 415.379.5442 Fax: 415.379.5705	The licensed Pest Control Advisor is responsible for establishment and oversight of the CAS Pesticide Safety Program including record keeping, use reporting, training and observance of federal, state and local regulations. In addition, the Pest Control Advisor must develop written recommendations for all pesticides used at the Academy and report all pesticide usage to the Dept. of Agriculture and the Dept. of the Environment.
Moss Room Executive Chef	Michael Morrison	Contact through Kevin Manalili	———	Kitchen supervisor of the Moss Room
Structural Integrated Pest Management Operator	Luis Agurto Jr., President of Pestec	luisagurtoiv@ipmprovider.com	415.671.0300	Contract supervisor for Pestec's services to the California Academy of Sciences.
Service representative	Patrick Ray	patrick@ipmprovider.com	415.671.0300	Pestec Service Technician

3. The San Francisco Integrated Pest Management Ordinance

In 1996 the City and County of San Francisco officially adopted an integrated pest management (IPM) policy requiring city properties to minimize the use of pesticides to the maximum extent possible.

Definition of Integrated Pest Management

The City and County of San Francisco Department of the Environment defines Integrated Pest Management (IPM) in the San Francisco integrated pest management ordinance:

> "Integrated pest management" means a decision-making process for managing pests, which uses monitoring to determine pest injury levels and combines biological, cultural, physical, and chemical tools to minimize health, environmental and financial risks. The method uses extensive knowledge about pests, such as infestation thresholds, life histories, environmental requirements and natural enemies to complement and facilitate biological and other natural control of pests. The method uses the least toxic synthetic pesticides only as a last resort to controlling pests.

The primary objective of any IPM plan is to prevent pest activity through source reduction. Eliminating site conditions that provide a habitat for pests to thrive is a precondition for successful pest management. Secondary management options, or pest controls, are employed when pest activity is already present. When non-pesticide options have been exhausted, and only as a last resort, pesticides from the San Francisco Department of the Environment reduced risk pesticide list may be applied only with **prior approval** from California Academy of Sciences Pest Control Advisor. All pesticide applicators **must** abide by California Academy of Sciences Pesticide Safety Protocols.

The IPM decision-making framework

(1) Monitor each pest ecosystem to determine pest population, size, occurrence, and natural enemy population, if present. Identify decisions and practices that could affect pest populations. Keep records of such monitoring;

(2) Set, for each pest at each site, and identify in an IPM implementation plan, an injury level, based on how much biological, aesthetic or economic damage the site can tolerate;

(3) Consider a range of potential treatments for the pest problem. Employ non-pesticide management tactics first. Consider the use of chemicals only as a last resort and select and use chemicals only within an IPM program and in accordance with the provisions of this Chapter.

4. Pestec Integrated Pest Management Providers

Pestec IPM Providers provide Structural Pest Management services to the California Academy of Sciences. Pestec is an EcoWise Certified and Green Shield Certified Integrated Pest Management Operator. These two certifications are third party certifications that audit the practices employed by Pestec for the purposes of pest management. The certifications support methodology that focuses on IPM methods over chemical use for the control of pests. The limits imposed on Pestec's pest management methods are more stringent than those required by the San Francisco IPM Ordinance.

5. LEED Credits for Integrated Pest Management

SS Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan

Intent

To preserve ecological integrity, enhance natural diversity, and protect wildlife while supporting high performance building operations and integration into the surrounding landscape.

Requirements

Have in place an environmentally sensitive management plan for the site's natural components. The plan must employ best management practices that significantly reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff (e.g. gasoline, oil, antifreeze, salts) compared with standard practices the plan must address all of the following operational elements.

Outdoor integrated pest management (IPM), defined as managing outdoor pests (plants, fungi, insects, and/or animals) in a way that protects human health and the surrounding environment and that improves economic returns through the most effective, least risk option. IPM calls for using least toxic chemical pesticides, minimum inspection and monitoring. The outdoor IPM plan must address all of the specific IPM requirements listed in EQ Credit 3.9, Green Cleaning: Indoor Integrated Pest Management, including preferred use of non-chemical methods, definition of emergency conditions, and universal notification (advance notice of not less than 72 hours under normal conditions and 24 hours in emergencies before a pesticide other than a least-toxic pesticide, is

applied in a building or on surrounding grounds that the building management maintains). The outdoor IPM plan must also be integrated with any indoor IPM plan for the building as appropriate.

Pesticide Notification Procedures

A requirement of LEED Platinum Certification is the use of "least toxic" chemical methods for the purposes of pest management. **Least toxic is defined as a pesticide from the San Francisco Reduced Risk Pesticide List marked as Tier III "least toxic" material.** The use of any pesticide other than a Tier III pesticide must be approved for use according to the CAS Pesticide Safety Program (See Appendix A), and building occupants must receive universal notification according to the requirements listed in Section 304 of the San Francisco Integrated Pest Management Ordinance.

- **Universal Notification**: Universal notification will be provided by the manner listed above as per the San Francisco IPM Ordinance. Email notices to building occupants will also be used to provide universal notification of pesticide applications not listed as Tier III on the San Francisco Reduced Risk Pesticide List.

- **Emergency Conditions:** Emergency conditions for pesticide use without 4 day notification are identified in the San Francisco Integrated Pest Management Ordinance Section 304 (d) as conditions requiring the approval from the San Francisco Department of the Environment "to apply a pesticide without providing a three-day advance notification in the event of a public health emergency or to comply with worker safety requirements."

Indoor Environmental Quality Credit 3.9: Green Cleaning: Indoor Integrated Pest Management

Intent

To reduce the exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particulate contaminants that adversely affect air quality, human health, building finishes, building systems and the environment.

Requirements

Develop, implement, and maintain an indoor integrated pest management (IPM) plan, defined as managing indoor pests in a way that protects human health and the surrounding environment and that improves economic returns through the most effective, least-risk option. IPM calls for using least-toxic chemical pesticides, minimum use of chemicals, use only in targeted locations, and use only for targeted species. IPM requires routine inspection and monitoring. The plan must include the following elements, integrated with any outdoor IPM plan for the site as appropriate.

- Integrated methods, site or pest inspections, pest population monitoring, evaluation of the need for pest control and one or more pest control methods, including sanitation, structural repairs, mechanical, and living biological controls, other non-chemical methods, and if nontoxic options are unreasonable and have been exhausted, a least-toxic pesticide.

- Specification of the circumstances under which an emergency application of pesticides in a building or on surrounding grounds being maintained by building management can be conducted without complying with the earlier provisions.

- A communications strategy directed to building occupants that addresses universal notification, which requires notice of not less than 72 hours before a pesticide under normal conditions and 24 hours after application of a pesticide in emergency conditions, other than a least-toxic pesticide, is applied in a building or on surrounding grounds that the building management maintains.

Any cleaning products included in the integrated pest management policy must meet the requirements for EQ Credits 3.4-3.6.

6. IPM at the California Academy

Academy Pest Committee

The California Academy of Sciences Pest Committee meets monthly to discuss and strategize solutions for pest problems throughout the building. The Pest Committee is responsible for forming policies that guide staff cultural behavior to discourage pests and minimize pest habitat. The Pest Committee also performs unannounced quarterly inspections throughout the building and reports observed deficiencies to department managers.

If deficiencies are not resolved with any given area within 30 days, Pestec will contact the Pest Committee and the IPM coordinator with a list of deficiencies.

IPM Coordinator

The Operations Director will act as the California Academy of Sciences on-site IPM coordinator. An IPM coordinator is the individual who has day-to-day oversight of the integrated pest management practices employed at the Academy.

Academy Pest Prevention Policy

The Academy of Sciences Pest Prevention Policy (see Appendix B) is intended to guide staff behavior to discourage pests in the building. It is the responsibility of managers and supervisors to train all new staff on this policy and enforce the policy within their departments.

Academy Pesticide Safety Program

The Academy Pesticide Safety Program (see Appendix A) is part of the California Academy of Sciences Chemical Hygiene Plan. This plan serves to limit exposure and risk associated with the use of hazardous chemicals. The Academy Pesticide Safety Program also ensures pesticide applications performed at the California Academy of Sciences meet the regulatory requirements of the Worker Protection Standard of the Environmental Protection Agency and the California Department of Pesticide Regulation.

The Academy IPM Plan

The Academy IPM Plan (see introduction) describes methods of monitoring and detecting pest activity with an outline of recommended physical and chemical controls for specific pests. The plan also provides information on structural and operational changes and practices that serve to abate and prevent pest activity at this institution. This

plan is administered by Kevin Manalili, Operations Director and Kristen Natoli, Pest Control Advisor.

IPM Plan Evaluation

This plan is intended to be a "living document" that should be updated to reflect the changes in the facility, applicable controls, and evaluated in terms of achievement of management objectives, correction of deficiencies, and adherence to the service schedule. This evaluation will be scheduled annually by the chair of the Academy Pest Committee to coincide with the June (end of fiscal year) Pest Committee meeting.

Reports that will be generated out of PestPac for review will include:

- deficiency report that includes open and resolved reported deficiencies
- call back report (unscheduled service visits)
- pest activity report

Pestec will make changes to this document upon approval and acceptance by the Pest Committee before the end of each fiscal year, June 30th.

Updating the Academy IPM Plan

This plan should be updated annually after an annual review on the effectiveness on the IPM policy and strategy in place. Pest trends and chemical use trends will be vital information to this evaluation. All changes should be coordinated through Building Operations and the IPM coordinator/ Plan administrator.

7. Overall Management Objectives of the Integrated Pest Management Plan

1. To limit human health challenges associated with pest activity.
2. To prevent damage to invaluable research and living collections associated with pest activity.
3. To limit aesthetic and economic damages to Academy exhibits and architecture associated with pest activity.
4. To limit economic damage to the California Academy of Sciences caused by pest activity.
5. To prevent the establishment and spread of pests within the Academy and in the adjoining landscape.
6. To manage pest populations in a manner consistent with the San Francisco Integrated Pest Management Ordinance, LEED Building Certification, EcoWise Certified and Green Shield Certified standards.

8. Factors Influencing Management

1. Safety for Academy staff, visitors, and live specimens while performing pest management. Management strategies must minimize worker injuries related to performing pest management.
2. Pest biology and ecology: These influence available and effective Management strategies.
3. Budget: Pest management is restricted to a particular budget, which must be adhered to.
4. Ongoing building deficiencies that give rise to access for pest populations. Ongoing building deficiencies must be dealt with to maintain an environment inhospitable to pests.
5. General aesthetics of the building and public areas. Public use and visibility limits the number of and types of monitoring devices that may be employed.
6. High traffic and limited storage space contributes to pest introduction, clutter, and unidentified pest activity.
7. Multi-purpose use of building with varied interests, familiarity with IPM, and pest/deficiency tolerances.

9. Communication Pathways

Communication between pest management specialists and staff working in areas impacted by pests is a critical component to any integrated pest management program. Empowering staff to watch for and report any pest sightings or pest damage can greatly improve the effectiveness of monitoring programs and allow for a more rapid, better informed response to pest problems. Staff impacted by pest problems is more likely to support the IPM program if they have the assurance of direct communication and rapid response.

The next sections describe the communication pathways for structural and landscape pest sightings and response by pest management specialists.

Reporting Pest Sightings

Pest sightings may be reported by any staff member at the California Academy of Sciences through a simple form located on the intranet at:

http://intranet.calacademy.org/busdev/ops/SitePages/Pest%20Prevention.aspx

This form specifies location, type of pest and contact info for the person reporting to facilitate response by pest management practitioners.

Training and Communicating Policies to Academy Staff

The Academy's Pest Prevention Policy contains guidelines regarding the storage of food in staff areas. This policy must be communicated to all new and current staff. The policy is enforced through quarterly inspections.

The Pest Committee is responsible for reporting ongoing problems to the Operations Director, who will then coordinate with department management where trouble spots recur.

Reporting Deficiencies to the Operations Director

The pest sightings reported on the intranet are automatically emailed to the Operations Director and Pestec.

Pestec communicates the sightings to the technician responsible for service at the California Academy of Sciences. The pest submission form will be kept with the Academy's paperwork and copied to the Academy's online account.

Technician Responses

Pestec technicians will generally respond to pest reports within a few days of receiving a report. The technician will monitor and evaluate the pest action level and determine the appropriate response including recommendations for resolving any deficiencies.

Technician Report

Pestec technicians submit a report that may be accessed and viewed by pest management specialists and California Academy of Sciences operations staff within 36 hours. This report will include the deficiencies observed and any action taken by technicians to manage and monitor pests and pest activity.

Pestec Supervisors

Pestec Supervisors evaluate technician reports to provide guidance on resolving pest issues. If pest issues appear to be horticultural in nature or originate in the landscape they will communicate with the horticulture Pest Control Advisor to collaborate on solutions.

Any deficiencies not resolved in 30 days will be reported to the Operations Director.

Materials Use Reporting

All pesticide use must be approved by Kristen Natoli, Pest Control Advisor for the California Academy of Sciences and liaison with San Francisco Department of the Environment. All pesticide use must be reported to the Department of the Environment, City and County of San Francisco.

Kristen Natoli and appropriate collection managers must review all pest Management strategies that may impact the Academy living or research collections.

Notification Requirements

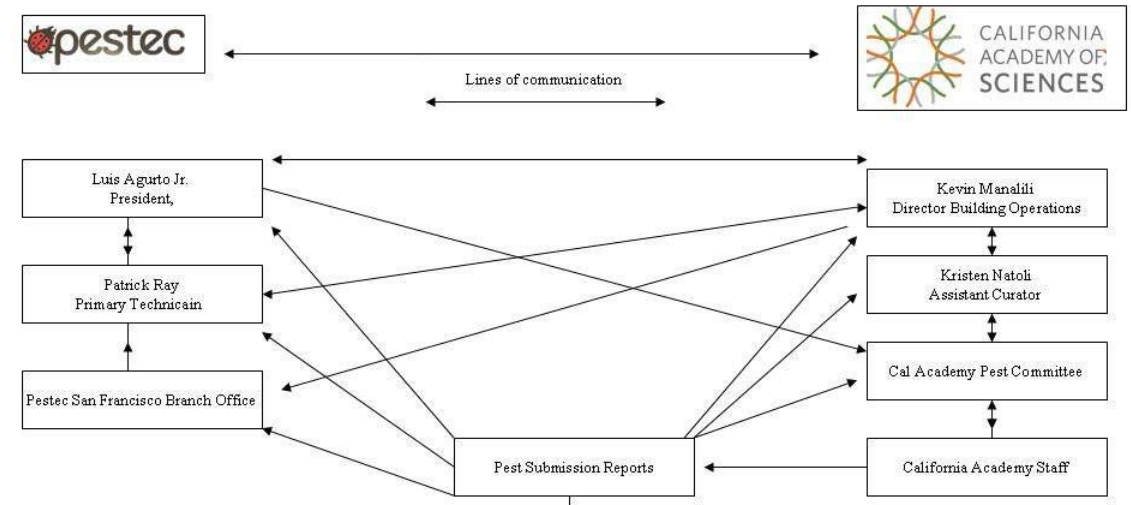
Notification of pesticide applications must abide by the San Francisco IPM Ordinance requirements:

- Notification of all pesticide applications must be posted **three days** before application of the pesticide product and remain posted for **four days** after application.

- Signs shall be posted (i) at every entry point where the pesticide is applied if the pesticide is applied in an enclosed area, and (ii) in highly visible locations around the perimeter of the area where the pesticide is applied if the pesticide is applied in an open area.

- Signs shall contain the name and active ingredient of the pesticide product, the target pest, the date of pesticide use, the signal word indicating the toxicity category of the pesticide product, the date for re-entry to the area treated, and the name and contact number for the City department responsible for the application.

Communication Flow Chart



These lines of communication represent the information flow essential to Pestec's services at the California Academy of Sciences.

The Director of Building Operations can communicate directly with The Pestec Office, Luis Agurto, or Patrick Ray to coordinate any service requests.

Pest submission reports from Cal Academy Staff will be forwarded to the Pestec office, Luis Agurto, Patrick Ray, members of the Cal Academy Pest Committee and saved in the Pestec Customer Access account for the Cal Academy. Patrick will respond to these reports each week during his weekly service.

Luis Agurto Will report monthly to the Cal Academy Pest Committee on ongoing deficiencies and pest problems on-site

10. Horticulture and Landscape Pest and Disease Management

All planted landscapes are susceptible to weed, pest and disease infestations. Eradication of all pests and diseases in such environments is not a reasonable or achievable goal. Instead the primary goal should be healthy, attractive plantings supporting a balanced, complex, healthy ecosystem. Integrated Pest Management is the best strategy to achieve a balanced ecosystem in planted landscapes.

Landscape professionals can expect to spend as much as 25% of their work hours addressing and managing pest issues. All aspects of plant care and landscape management directly or indirectly impact pest establishment. Horticulture practice should be informed by established IPM principles and should take local pests and plant susceptibility into account.

Identification and knowledge of pests along with good record keeping are critical to developing effective and creative management strategies. Establishing injury thresholds, timing treatments to maximize effectiveness and evaluating treatments for effectiveness are also essential components of a successful program.

California Academy of Sciences horticulture and pest management practices must be consistent with the requirements of the San Francisco IPM ordinance.

Landscape Design and Horticulture Practice

Many aspects of landscape design and cultural strategies common in horticulture practice will influence the establishment or prevention of pests in the landscaped environment. Landscape design and horticulture practices must be guided by the principles and practices of IPM to discourage pests and encourage healthy plantings that may resist pest establishment. Design and cultural practices that should be informed by IPM practices may include but are not limited to:

- Landscape design
- Appropriate plant selection
- Soil and media selection and site preparation
- Ensuring new planting materials are clean of pests and disease
- Irrigation design
- Irrigation and watering practices
- Nutrient management
- Appropriate cleaning and maintenance of tools and equipment

IPM Action Table

In accordance with the framework of the San Francisco IPM ordinance, each of the potential pest threats to the California Academy of Sciences must be monitored; have an injury level determined; and treated in a manner consistent with the city's IPM ordinance.

The IPM action table below lists the determinants of the injury level for pests commonly encountered in landscape and horticulture pest control, or what is also known as an action threshold, along with a framework for responding to particular pest infestations.

The actions taken by pest management professionals may vary depending on particular site circumstances and the concerns of stakeholders in pest management at a given site. The actions are used as guidance when encountering a particular pest. The efficacy of the actions are tried and proven; however each pest infestation provides new challenges and new opportunities to develop new methods of pest management not listed below.

Horticulture IPM Action Table

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Piercing / sucking insects	**Level One (lowest) Pest Sighting**	Visual inspection, look for plant damage	Pest sighting	• Evaluate plant for other signs of stress; address any other plant health issues related to horticulture practice. • Hose off plants aggressively to remove and disturb pests and eggs. • Monitor for signs of predation and parasitism by biocontrol agents.
Piercing / sucking insects	**Level Two: Moderate - large population**	Visual inspection, look for plant damage	Plant damage on 10% of species or population of plants or aesthetic impact.	• Evaluate plant for other signs of stress; address any other plant health issues related to horticulture practice. • Hose off plants aggressively to remove and disturb pests and eggs. • Identify appropriate biocontrol agents and release substantial numbers. • Hand-clean at least 1x per week.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Piercing / sucking insects	**Level Three: Infestation**	Visual inspection, look for plant damage	Plant damage on more than 50% of vulnerable species or plant population.	• Evaluate plant for other signs of stress; address any other plant health issues related to horticulture practice. • Daily high pressure-wash to • Remove and disturb pests and eggs. • Identify appropriate biocontrol agent and release in large numbers. • Consider replacement of plants with resistant varieties • As last resort consider appropriate and approved chemical treatment.
Fungus Gnats and Shoreflies	**Level One: (lowest) Pest Sighting**	Visual inspection, look for plant damage	Pest sighting	• Reduce watering, allow soil to dry down in between watering.
Fungus Gnats and Shoreflies	**Level Two: Moderate – large population**	Visual inspection, look for plant damage	Plant damage, impact aesthetics	• Reduce watering, allow soil to dry down in between watering. • Identify appropriate biocontrol agents and release in large numbers • Where possible top-dress soil with #212 sand.
Fungus Gnats and Shoreflies	**Level Three: Infestation**	Visual inspection, look for plant damage	Significant root damage to plants, damping off	• Reduce watering, allow soil to dry down in between watering. • Identify appropriate biocontrol agents and release in large numbers • Where possible top-dress with #212 sand. • As a last resort consider appropriate and approved chemical treatment

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Lepidoptera	**Level One (lowest) Pest Sighting**	Visual inspection, look for plant damage	Pest sighting	• Hand clean plants of caterpillars, pupa and eggs • Monitor for signs of predation and parasitism by biocontrol agents.
Lepidoptera	**Level Two: Moderate - Large population**	Visual inspection, look for plant damage	Plant damage on 10% of species or population of plants or aesthetic impact.	• Prune or hand clean plants regularly to remove pests and eggs • Identify appropriate biocontrol agents and release substantial numbers.
Lepidoptera	**Level Three: Infestation**	Visual inspection, look for plant damage	Plant damage on more than 50% of vulnerable species or plant population.	• Prune or hand clean plants regularly to remove pests and eggs. • Identify appropriate biocontrol agents and release substantial numbers. • Consider replacement of plants with resistant varieties. • As last resort consider appropriate and approved pesticide treatment
Slugs / snails	**Level One (lowest) Pest Sighting**	Visual inspection, look for plant damage	Pest sighting	• Evaluate irrigation and reduce irrigation if possible to reduce suitable habitat. • Hand clean to remove pests and eggs.
Slugs / snails	**Level Two: Moderate - large population**	Visual inspection, look for plant damage	Plant damage on 10% of species or population of plants or aesthetic impact.	• Evaluate irrigation and reduce irrigation if possible to reduce suitable habitat. • Hand clean to remove pests and eggs. • Remove debris in the area around pest infestations to reduce habitat. • Strategize planting of vulnerable plants during times of reduced pest activity

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Slugs / snails	**Level Three: Infestation**	Visual inspection, lab analysis	Plant damage on more than 50% of vulnerable species or plant population.	• Evaluate irrigation and reduce irrigation if possible to reduce suitable habitat. • Hand clean to remove pests and eggs. • Remove debris in the area around pest infestations to reduce habitat. • Strategize planting of vulnerable plants during times of reduced pest activity. • Consider replacement of vulnerable plants with resistant varieties. • As last resort consider appropriate and approved bait.
Weevils	**Level One (lowest) Pest Sighting**	Visual inspection, look for plant damage	Pest sighting	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and pest resistance • Reduce soil moisture to discourage establishment of pests.
Weevils	**Level Two: Moderate - large population**	Visual inspection, look for plant damage	Plant damage on 10% of species or population of plants or aesthetic impact.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and pest resistance • Reduce soil moisture to discourage establishment of pests. • Place shelter for adults at base of plants to harbor adults, remove periodically and freeze. • Identify appropriate nematode treatments and release in substantial numbers

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Weevils	**Level Three: Infestation**	Visual inspection, look for plant damage	Plant damage on more than 50% of vulnerable species or plant population.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and pest resistance • Reduce soil moisture to discourage establishment of pests. • Place shelter for adults at base of plants to harbor adults, remove periodically and freeze. • Identify appropriate nematode treatments and release in substantial numbers • Consider replacement of host plants with resistant varieties • As a last resort consider appropriate and approved pesticide treatment
Foliar Pathogen	**Level One (lowest) first sign of disease**	Visual inspection, lab analysis	First visual evidence of disease, limited leaf damage.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Where possible without adding to plant stress remove damaged leaves to reduce pathogen
Foliar Pathogen	**Level Two: moderate infection**	Visual inspections, lab analysis	Plant damage on 10% of species or population of plants or aesthetic impact.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Where possible without adding to plant stress remove damaged leaves to reduce pathogen. • Where possible alter environmental controls to discourage pathogen or prune plants to allow improved air circulation.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Foliar Pathogen	**Level Three: Infestation**	Visual inspection, lab analysis	Plant damage on more than 50% of vulnerable species or plant population.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Where possible without adding to plant stress remove damaged leaves to reduce pathogen. • Where possible alter environmental controls to discourage pathogen or prune plants to allow improved air circulation. • Consider replacement of plants with resistant varieties. • As last resort consider appropriate and approved chemical treatment.
Soil / Root Pathogen	**Level One (lowest) first sign of disease**	Visual inspection, lab analysis	Limited leaf damage or damage confined to less critical portion of plants	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Carefully monitor soil moisture. Irrigate appropriately to discourage pathogen. • Remove dead, diseased plant material promptly to reduce pathogen.
Soil / Root Pathogen	**Level Two: moderate infection**	Visual inspections, lab analysis	Plant damage on 10% of species or population of plants or aesthetic impact.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Carefully monitor soil moisture. Irrigate appropriately to discourage pathogen. • Strongly consider replacing susceptible plants with resistant varieties. • Remove dead diseased plant material promptly along with contaminated soil. Replace with clean soil.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Soil / Root Pathogen	**Level Three: Infestation**	Visual inspection, accurate identification.	Plant damage on more than 50% of vulnerable species or plant population.	• Evaluate plants for signs of stress, strategize cultural practices to maximize plant health and disease resistance. • Carefully monitor soil moisture. Irrigate appropriately to discourage pathogen. • Remove infected plant material and soil. Replace with clean soil and resistant plants. • As a last resort consider treatment with appropriate and approved chemical treatment to protect uninfected plants.
Weeds	**Level One: First sighting of weed**	Visual inspection, accurate identification.	Presence of identifiable weed	• Hand-pull prior to flowering. • Monitor weekly for additional seedlings in the same vicinity.
Weeds	**Level Two: Moderate to large population**	Visual inspection, accurate identification.	Flowering plants or competition with more than 10% of desirable plants	• Hand-pull prior to flowering. • Monitor weekly for additional seedlings in the same vicinity. • Where appropriate mow or scythe plants to remove flowers. • Consider increasing concentration of desirable plants to create good coverage.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Weeds	**Level Three: infestation**		Weed population outcompeting or severely impacting more than 50% of desirable plants in a landscaped area, weeds potentially causing structural damage.	• Hand pull prior to flowering. • Monitor weekly for additional seedlings in the same vicinity. • Where appropriate mow or scythe plants to remove flowers. • Consider increasing concentration of desirable plants to create good coverage. • Consider solarization of soil and replanting with more competitive plants. • As a last resort consider appropriate and approved chemicals for spot treatment.

Proposed Methods of Monitoring and Detection

Plants and landscape in indoor and outdoor landscaped exhibits will receive regular visual inspection by horticulture staff for signs of pests and disease and evaluation of current pest management strategies.

- All evidence of pests, pest damage or disease will be recorded on monitoring sheets with a quantitative evaluation of pest population and / or impact to the landscape.
- Pests will be accurately identified for further evaluation.
- Visual inspection will include identification and evaluation of biological control agents. This information will also be recorded and used to inform pest management decisions.
- Monitoring/trapping devices such as pitfall traps and sticky traps will be used to assist evaluation where compatible with exhibit animals.
- Horticulture staff will perform follow-up inspections to evaluate pest management procedures and record observations.

Control Methods for Key Landscape Pests

Piercing / Sucking Insects and Mites

Piercing / sucking insects use microscopic straw-like mouthparts to pierce the leaves and stems of plants to feed on the sap. Short life cycle and high reproduction rates typical of

these insects allows for rapid, exponential increase in populations. Although infestations of these pests do not generally kill healthy plants they have the potential to:

- Spread virus
- Impact leaf development and aesthetics of plant morphology
- Excrete a sticky substance called 'honeydew' which can be colonized by unsightly black 'sooty mold'
- Encourage colonization of Argentine Ants *(Linepithema humile).*

Management Strategies

Plants under stress are more susceptible to pest infestations. Selecting suitable plants, managing cultural activities and managing the growing environment to maximize plant health and reduce pest habitat can significantly reduce pest outbreaks.

Close monitoring of plants to detect pest problems when populations are low will improve the success of any pest control strategies particularly biological control programs.

Argentine ants *(Linepithema humile)* have a beneficial relationship with many species of piercing / sucking insects. These ants will actively cultivate, protect and spread insect pests, reducing effectiveness of treatment strategies and biological control programs. They should be actively discouraged from colonizing landscape areas and planted exhibits when possible.

Plant Mites

Monitoring

- Watch for russeting and / or stippling of leaves, as this is an indication of the presence of mites.
- Dry, hot weather will often bring on mite infestations, particularly if plants are water stressed.
- Mites reproduce quickly so early detection is critical. If webbing is visible the population is likely quite large.

Cultural Strategies

- Most pest mites prefer low humidity. Frequent hosing of underside of leaves can increase local humidity preventing mite infestations or dislodge webbing, mites and eggs from infested plants.
- Avoid over-fertilizing. Heavy fertilizing can improve pest success and cause rapid population growth
- If possible remove and destroy heavily damaged leaves to reduce population.

- For outdoors exhibits monitor closely for naturally occurring beneficial insects such as predatory mites. Consider planting banker plants to attract beneficial insects.

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat.
- Three predatory mites have proven successful in controlling pest mite populations in the planted exhibits at the California Academy of Sciences: *Amblyseius californicus*, *Amblyseius swirskii* and *Phytoseiulus persimilis*.
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and horticultural oils are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Thrips

Monitoring

- Watch for stippling of leaves, silvery coloring with black dots on underside of leaves or misshapen new leaves, as these are indications of the presence of thrips.
- Heavy flowering and warm weather will often bring on thrips infestations. Monitor flowers at mid-day for active thrips.
- Thrips reproduce quickly so early detection is critical.

Cultural Strategies

- Frequent hosing of underside of leaves can increase local humidity preventing thrips infestations or dislodge adults and larvae from infested plants.
- Avoid over-fertilizing as heavy fertilizing can improve pest success and cause rapid population growth
- If possible remove and destroy damaged and infested leaves to reduce population
- For outdoors exhibits monitor closely for naturally occurring beneficial insects. Consider planting banker plants to attract beneficial insects.

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat.
- Thrips pupate in the soil beneath the plants. Incorporating biological control agents such as soil dwelling mites or nematodes that will feed on pupating thrips as well as those that feed on thrips on the plant will improve success of the biological control program.
- The following biological control agents have proven successful in helping to control thrips populations in the planted exhibits at the California Academy of Sciences: *Orius insidiosus, Amblyseius cucumeris, Amblyseius swirskii, Hypoapsis aculifer, Steinernema feltiae*.
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and horticultural oils are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Aphids

Monitoring

- Watch for misshapen new leaves or black sooty mold, as these are indications of the presence of aphids.
- Fertilizing and lots of active new growth will often bring on aphid infestations. Monitor closely under these conditions.
- As aphids are viviparous (live bearing) and reproduce parthenogenetically they are capable of explosive population growth. Early detection is critical for control.

Cultural Strategies

- Hosing off plants to dislodge aphids will provide some control. Removal of sooty mold and honeydew excreted by aphids will improve aesthetics and may aid in establishment of biological control agents.
- Avoid over-fertilizing. Heavy fertilizing is particularly associated with aphid outbreaks.
- For outdoors exhibits monitor closely for naturally occurring beneficial insects and evidence of parasitism such as mummified aphids.

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit and if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat. Particularly watch for evidence of Ladybugs *(Hippodamia convergens*) and parasitic wasps (*Aphidius sp*.).
- Release of combinations of predators and parasitoids can be more effective at providing long-term control.
- The following biological control agents have proven successful in helping to control aphid populations in the planted exhibits at the California Academy of Sciences: *Aphidius sp., Aphidoletes aphidmyza.*
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and horticultural oils are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Mealy Bugs

Monitoring

- Honeydew on leaf surfaces and cottony masses on the underside of leaves are common signs of mealy bug infestations.
- Be aware when monitoring that juvenile Mealy bug Destroyer beetles (*Cryptolaemus montrouzierii),* an aggressive predator of mealy bug, closely resemble adult mealy bugs. The ratio of predator to prey populations should influence treatment decisions.

Cultural Strategies

- Hosing off plants to dislodge mealy bugs and egg masses is an effective means of control. Removal of sooty mold and honeydew excreted by mealy bug will improve establishment of biological control agents.
- Avoid over-fertilizing. Heavy fertilizing can improve pest success and cause rapid population growth.
- For outdoors exhibits monitor closely for naturally occurring beneficial insects and evidence of parasitism.

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit and if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat. Root mealy bug in outdoor exhibits may be controlled using beneficial nematodes.
- Release of combinations of predators and parasitoids can be more effective a providing long-term control.
- The following biological control agents have proven successful in helping to control mealy bug populations in the planted exhibits at the California Academy of Sciences: *Cryptolaemus montrouzierii, Leptomastix dactophyll, Aphidioletes aphidmyza and Anagyrus sp.*
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and horticultural oils are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Scale

Monitoring

- Honeydew on leaf surfaces and the presence of black 'sooty mold' are common signs of scale infestations.
- There are many species of scale that commonly infect horticulture plantings. Successful treatment and biological control applications depend on positive identification.
- Scale is a sedentary insect for most life stages except the earliest life-stage or 'crawler' stage. The crawlers are the dispersal stage for scale and are particularly vulnerable. Identifying populations at this stage is critical for control.
- Watch for evidence of parasitisation in scale populations, as there are many species of naturally occurring parasitic wasps that will provide good control of these pests. The ratio of predator to prey populations should influence treatment decisions.

Cultural Strategies

- Hosing off plants to dislodge scale, crawlers and egg masses is an effective means of control. Removal of sooty mold and honeydew excreted by scale will improve establishment of biological control agents.
- Avoid over-fertilizing. Heavy fertilizing can improve pest success and cause rapid population growth.
- For outdoor exhibits monitor closely for naturally occurring beneficial insects and evidence of parasitism.

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit and if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat.
- Release of combinations of predators and parasitoids can be more effective a providing long-term control.
- The following biological control agents have proven successful in helping to control scale populations in the planted exhibits at the California Academy of Sciences:

  Soft scale*: Metaphycus sp., Rhyzobius sp.,*

  Hard scale*: Aphytis melinus*

- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and horticultural oils are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Fungus Gnats and Shoreflies

Fungus gnats **(**families Mycetophilidae and Sciaridae) and Shoreflies **(**family Ephydridae) occur around damp soil and decaying vegetation. Both may inhabit moist potting soil or planting media and are primarily nuisance pests. With large infestations the larva may damage roots of plants causing stress and making plants susceptible to root pathogens.

Both Fungus Gnats and Shoreflies lay their eggs in moist soil or organic debris and their larva develop in the same media.

Monitoring

- Fungus gnats are dark, delicate looking insects that somewhat resemble mosquitos. They tend to remain in planted areas and often run or rest on the soil surface.
- Shoreflies are robust with short legs. Their wings are dark with light spots. Shoreflies are less likely to take flight than fungus gnats.
- Larva may be visible approximately ¼ - ½ " below soil surface
- A slice of potato placed on soil surface will attract larva and may be used for monitoring purposes
- Yellow sticky traps are also effective for monitoring both flies

Cultural Strategies

- Both Fungus Gnats and Shoreflies *require* moist soil for reproduction and development of larva.
- Drying down soil between irrigations and cleaning up free standing water is often sufficient to control these nuisance pests.
- Top-dressing with #212 sieve size sand can interrupt ovipositing sufficiently to reduce establishment
- Avoid using incompletely composted organic matter or pasteurize prior to use to avoid introducing Fungus gnats or Shoreflies
- Inspect new plant material and remove soil if flies are present prior to planting to prevent introduction

Biological Control Strategies

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit and if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat.
- Release of combinations of predators and parasitoids can be more effective a providing long-term control.
- The following biological control agents have proven successful in helping to control Fungus Gnat and Shoreflie populations in the planted exhibits at the California Academy of Sciences:
    - Predatory mite: *Hypoapsis aculeifer*
    - Nematodes: *Steinernema feltiae*
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and *Bt* based pesticides are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Lepidoptera

Caterpillars, which are the juvenile stage of Lepidoptera (moths and butterflies), feed voraciously on plants. Although they do not reproduce exponentially, a small colony can have a devastating and destructive impact on horticulture plantings from aggressive feeding.

Many different species of caterpillar attack horticulture plants, particularly in outdoor landscape areas. Lepidoptera are often host specific and seasonal and adult Lepidoptera will typically lay their eggs near or on a host plant.

Lepidoptera form a chrysalis or cocoon during pupa stage that is unique to each species and can aid identification.

Management Strategies

Plants under stress are more susceptible to pest infestations. Selecting suitable plants, managing cultural activities and managing the growing environment to maximize plant health and reduce pest habitat can significantly reduce pest outbreaks.

Close monitoring of plants to detect the presence of Lepidoptera eggs or pupa prior to hatching or emerging will improve the success of any pest control strategies particularly biological control programs.

Proper identification of Lepidoptera pests and their host plants will improve success of the pest management program. Consider replacement of susceptible host plants with non-host species.

Monitoring

- Caterpillars typically cause visible and identifiable damage. Watch for leaves with large missing chunks or holes or rolled leaves that may contain caterpillars in the center.
- Some caterpillars live in the stem or root crown of plants. Wilted plants in moist soil should be examined for the presence of these caterpillars or borers.
- Caterpillar eggs are often laid in visible clusters on leaves or stems. Pupae in the form of chrysalis or silk covered cocoon are often visible on undersides of leaves.
- Accurate record of the impacted host plants and timing of pest damage will aid in proper timing of pest Management Strategies in future seasons. During the active season for the pest monitor as frequently as possible to increase success of the pest management program.

Cultural Strategies

- Replace host plants with non-host species where possible.
- Identify host plants and likely season of infestation and monitor for eggs or pupae. Prune or remove infested leaves, pupa, eggs or small caterpillars.
- For outdoor exhibits monitor for the presence of parasitized eggs and pupae or the remains of predated insects.

Biological Control

- Biological control agents are most effective in contained exhibits such as the Rainforest exhibit and if released when pest populations are still low. Outdoor exhibits will frequently attract beneficial insects from the surrounding habitat.
- The following biological control agents may aid in control of Lepidoptera populations: *Trichogramma spp.* and *Podisus maculiventris.* Release of *Trichogramma spp*. in outdoor exhibits may provide control.
- Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in early morning or early evening to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, Insect Growth Regulators and pesticides containing *Bacillus thuringiensis* are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Black Vine Weevil (Otiorhynchus sulcatus (Fabricius))

Weevils are any beetles from the from the Curculionoidea superfamily. There are many species, most less than /14" in size most herbivorous. Weevils attack many species of landscape plants and may become a very serious pest causing substantial damage to the landscape. Adult weevils frequently cause visible damage by chewing on leaves. 'Grubs' or juveniles of many weevils can bore into the crown or roots of the plant causing more critical damage by girdling the stem and potentially killing the plant. Plants damaged by grubs may wilt or show signs of drought stress.

Management Strategies

Plants under stress are more susceptible to pest infestations. Selecting suitable plants, managing cultural activities and managing the growing environment to maximize plant health and reduce pest habitat can significantly reduce pest outbreaks. Close monitoring of host plants to detect adult or juvenile weevil damage at an early stage will improve the success of any pest control strategies particularly biological control programs. Accurate identification of weevil pests and their host plants is critical to the success of the pest management program. Consider replacement of susceptible host plants with non-host species.

Monitoring

- Adult weevils will chew on the leaves of host plants. Look for characteristic notches on leaves particularly on the lower leaves of plants.
- Adults are most active at night and will burrow at the base of the plant during the day. Consider placing habitat at the base of suspect plants to monitor during the day to facilitate identification of weevils.
- Grubs feeding on roots of the plant may cause girdling of the stem. Wilted plants in moist soil should be examined for the presence of grubs in the soil or roots of the plant.
- Accurate record of the impacted host plants and timing of pest damage will aid in proper timing of pest Management strategies in future seasons. As grubs appear earlier in the season and have greater potential impact it is beneficial to begin monitoring for grubs before leaf damage from adults is visible. During the active season for the pest monitor as frequently as possible to increase success of the pest management program.

Cultural Strategies

- Replace host plants with non-host species where possible.
- Identify host plants and likely season of infestation and monitor for grubs and adults.
- Moist soil benefits the survival of eggs and larva and may encourage larva to move up the stem causing girdling. Minimize watering to discourage pest establishment.
- Create habitat for weevils such as burlap sheeting around desirable plants that may be removed periodically and frozen to destroy adults.

Biological Control

The following nematodes may aid in control of Black Vine weevil populations: Heterohabditis sp. and Steinernema sp.
Release at rates and frequency recommended by biological control supplier and monitor activity closely to ensure success of the biocontrol program. Release biocontrol agents in moist soil to improve establishment.

Chemical Control Strategies

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs. Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed. All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian. Biorational pesticides, Insect Growth Regulators are preferred treatments for these pests. Spot treat where possible and ensure good spray coverage when spraying or drenching pest-infested plants.

Slugs and Snails

Slugs and snails are soft-bodied mollusks that typically live in moist areas under leaf litter or in the soil. They are most active at night and can cause considerable damage and destruction particularly to tender new plants and shoots.

Slugs and snails require cool moist conditions for activity and successful reproduction. As they are hermaphroditic and can lay eggs several times a year, populations can increase quickly.

Management Strategies

Because slugs and snails require particular environmental conditions to thrive controlling these conditions or timing plantings of tender species to avoid these conditions can help to minimize damage.

Selecting plants that are tolerant, resistant or that will establish under warmer, drier conditions will allow for a better balanced system that could keep slug / snail damage below tolerance thresholds.

Monitoring

- Slugs and snails are quite visible in early morning hours or on wet days.
- Damage to new tender shoot is usually quite visible but may be difficult to distinguish from Lepidoptera damage. Shiny slime trails or damage confined to areas within 12" of height from soil surface generally suggests a slug / snail problem.
- Eggs are laid in clusters in dark moist areas and are spherical and pearly.

Cultural Strategies

- Eliminate potential habitat as much as possible, such as excess debris, boards, stones, etc.
- Manage irrigation to reduce humidity and moist surfaces. Allow soil to dry down between irrigations when possible, use drip irrigation instead of sprinkler when possible.
- Choose resistant plants. Time planting of tender plants with low slug / snail activity whenever possible.
- Hand removal of slugs and snail, particularly on tender new plants, may allow plants to establish sufficiently to resist further damage.
- Boards or flower pots placed near tender plantings can act as traps. Slugs and snails will retreat to them during the drier parts of the day. Daily monitoring and removal of slugs / snails from traps will reduce numbers locally.
- Copper foil may be used as a protective barrier against slugs and snails. Copper striping around legs of greenhouse benches or trunks of trees and shrubs may serve as a protective barrier against slug / snail infestations.
- Solarizing raised beds will kill slug / snail eggs in the soil.

Biological Control

Slugs and snails have many natural enemies including some ground beetles, toads and birds but none will likely provide sufficient control. At this time there are no biological control agents approved for release in Northern California. The Decollate Snail *Rumina decollata* has been released successfully in Southern California but is not approved for use locally.

Chemical Control

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational treatments and non-toxic baits are preferred for treating these pests. Time the treatments with activity of pests, avoiding treatment during hot dry periods or cold periods when the pests are not active.

Pathogens

Plant pathogens are ever present in all natural and landscaped areas and ornamental plantings. Many different species of pathogens may infect the leaves, stems and roots of ornamental plants.

As there are few treatment options for diseased plants disease prevention is in many cases the only method of disease management.

Management Strategies

Proper plant selection and cultural strategies that maximize plant health are critical to disease prevention.

Accurate identification of pathogens and an understanding of cultural conditions that favor particular diseases are the Pest Management practitioners' best tools.

Monitoring

- Plants under stress show general signs of ill health. Close examination of plants that look generally stressed can often rule out pest damage. These plants should be further examined for evidence of disease
- Pathogens can be extremely difficult to identify through visual symptoms and difficult to distinguish from abiotic problems. Try to rule out likely abiotic problems such as water stress, lighting impacts, climate or nutrient issues, as these are more common landscape problems. Contact a pathology lab for accurate diagnosis.

- Leaf pathogens may appear as colored or white growths on leaves, necrotic spots, see-through spots, necrosis along venation, mottling, disfiguring or developmental problems in leaves.
- Wilted plants in moist or wet soil suggest root, crown or stem disease. Visual examination of roots, crowns or stems may show rot or necrosis indicative of disease.

Foliar Pathogens

Cultural Strategies

- Plant resistant varieties.
- Healthy plants will be more likely to resist disease. Proper plant selection, site selection, spacing of plants, watering and nutrient management to maximize health of plants will improve disease resistance
- Cool wet conditions often favor foliar disease. Water early in the day to allow foliage to dry more quickly.
- Inspection and Removal: Inspect all new plant material for signs of pathogen and do not accept diseased plants. Remove diseased plant material as quickly as possible to reduce inoculum.
- Sanitation: keep landscape tools and equipment clean. When working with contaminated materials disinfect tools before storing and wash hands thoroughly.
- Weed removal: be aware of weedy plants that may harbor disease and maintain an aggressive program to control susceptible weedy plants.

Chemical Control

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides, beneficial bacteria and fungi, horticultural oils are preferred treatments. Time the treatments appropriately to maximize benefit. Spot treat where possible and ensure good spray coverage when spraying pest-infested plants.

Soil Pathogens

Cultural Strategies

- Plant resistant varieties.
- Unhealthy or stressed plants are particularly susceptible to root / stem / trunk pathogens. Proper plant selection, site selection, spacing of plants, watering and nutrient management to maximize health of plants will improve disease resistance.
- Plants in overly wet or compacted soil with poor drainage are much more susceptible to soil pathogens. Ensure proper drainage and amendment of soil and monitor soil moisture carefully.
- If plants are wilting check soil moisture **before** watering. Wilted plants in moist soil could be suffering from root or crown rot. Over-watering plants in this situation will exacerbate the problem.
- Inspection and Removal: Inspect all new plant material for signs of pathogen and do not accept diseased plants. Remove diseased plant material as quickly as possible to reduce inoculum and replace with resistant varieties of plants.
- Source soil and amendments from clean, reputable facilities. Ensure compost has achieved sufficient temperatures to eliminate pathogen.

Chemical Control

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Most chemical controls of soil pathogens will only work as a prevention to protect healthy plants from infection. Removal of diseased plants and appropriate timing of treatment is critical to the success of such treatments. Biorational pesticides, beneficial bacteria and fungi are preferred treatments. Spot treat where possible and ensure good coverage when drenching pest-infested plants.

Weeds

Weeds can be defined as any undesirable plants growing in a landscape exhibit. Weeds may compete with desirable plants for water and space and their population must be controlled to prevent negative impact on overall landscape design. Weeds may also harbor undesirable pests and diseases.

Management Strategies

Proper identification of weeds and their method and rate of propagation is essential in determining tolerance thresholds and prioritization of resources for weed control. Identifying method of establishment, propagation strategy, and seasonality of each weedy species will inform management decisions and maximize efficiency of control strategies.

Monitoring

- Learn to identify weeds at the earliest life stages possible to allow for early sighting and monitoring.
- Monitor for heavy seed producers that are approaching flowering stages to maximize efficiency of weed removal efforts.

Cultural Strategies

- Dense planting coverage will suppress many weeds and prevent establishment.
- Select appropriate plants and monitor watering. Well-established plants with healthy roots will compete more effectively with weed species.
- Hand removal is the safest, most effective means of weed control. Strategize hand weeding or hoeing timing to improve efficiency
- Weed removal is easier in wet soil following rain.
- Removing populations of small seedlings can be time consuming and not all seedlings will likely survive, however established plants with more developed root systems will be harder to remove. Time weeding to maximize ease of removal.
- Removing weeds before seed set can prevent one weed from turning into hundreds.
- Exclusion: Prevent weed seeds from entering planted areas on tools, equipment, clothing, or in new soil and amendments.
- Solarization: covering weedy soil with plastic for 4-6 weeks will kill many weeds and seeds.

Chemical Control

Chemical control should be a last resort for treatment of heavy infestations. All other strategies must be exhausted before resorting to chemical use. Chemical applications may compromise biological control programs.

Only chemicals listed in the San Francisco Reduced-Risk Pesticide List may be used at the California Academy of Sciences. All posting requirements by the San Francisco Integrated Pest Management ordinance must be observed.

All pesticide applications must have prior written approval by a licensed Pest Control Advisor. Pesticide applications in the vicinity of living collections must have prior approval from staff veterinarian.

Biorational pesticides and burn down chemicals are preferred for these pests. Spot treat where possible and ensure good spray coverage when spraying weeds.

References

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3. California Department of Pesticide Regulation: http://www.cdpr.ca.gov/

4. Bio-Integral Resource Center: http://www.birc.org/

5. Western Plant Diagnostic Network: https://www.wpdn.org/index.php

6. Radcliffe's IPM World Textbook: http://ipmworld.umn.edu/

7. Flint, Mary Louise. **Pests of the Garden and Small Farm**. University of California. 1990

8. Gill, S. and J. Sanderson. **Ball Guide to Identification of Greenhouse Pests and Beneficials.** Ball Publishing, Batavia, IL. 1998.

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11. Structural Integrated Pest Management

Service Schedule

1.) Weekly pest management inspection, monitoring, and treatments as necessary and defined by the approved IPM plan for the control of: ants, flies, German cockroaches, Oriental cockroaches, mosquitoes, mice, rats, and stored product pests. The entire facility will be inspected once each month with monitoring, deficiency, and pest control information recorded by "area" and maintained in the PestPac customer account. Services will be rendered at the following schedule. Changes to the schedule will be made to the IPM plan and submitted to the Committee when necessary:

Thursdays from 7am-10am

- 1st Thursday of the month B2-L3 West Pavilion office areas will be inspected. Approximately 22 permanent insect monitoring devices and various temporary mouse traps (in radiator chases) and stations. Hot spots on the main floor will also be serviced to remove trapped mice, such as at the North Coast beach, the Piazza, and behind garbage receptacles.

- 2nd Thursday of the month B2-L3 East Pavilion office areas will be inspected. Approximately 23 permanent insect monitoring devices and various temporary mouse traps (in radiator chases) and stations. Hot spots on the main floor will also be serviced.

- 3rd Thursday of the month the Collections Rooms will be inspected and insect monitors serviced/replaced as needed, as well as the B2 central areas and hot spots.

- 4th Thursday of the month the main floor exhibition areas will be inspected visually, the exterior will be inspected and the exterior trapping devices for rodents and flies serviced. This service will include inspection of drains on the pavement and roof for build-up of organic matter, standing water, and treatment for mosquitoes as needed.

2.) An additional one man hour per week is budgeted for unscheduled service calls, rodent trap follow-up, or additional treatments required for the pests listed above.

3.) This service will include participation and reporting to the Pest Committee once each month, one man-hour.

Night Trapping - SF Night service for rodent trapping to areas where traps or stations could not otherwise be placed for aesthetic reasons. Traps are set after hours and removed early AM. Service is provided on-call and by written authorization only.

Pest proofing, bio-hazardous clean up, consultation, and service for pests not listed will only be carried by written authorization.

Proposed Methods for Monitoring and Detection

The methods that will be utilized for monitoring IPM deficiencies such as food, water, harborage and access, and pest populations will consist of:

1. A "Pest Sighting Log Book" will be provided so that building occupants can record minor nuisance pest sightings or conditions conducive to them that can be addressed on the regular service visit. The reports will serve the function of:

- Providing an additional method for building occupants and the service representative to communicate
- Create an objective measurement of IPM efficacy by occupant reports
- Create an objective measurement of pest population by compiling “Pest Activity Trends" on every service

2. The on-going IPM service consists of visual inspections specifically for deficiencies that are conducive to pests. The service representative will inspect on every visit the identified "Pest Prone Places" (PPP's) that include areas inside and outside such as:

- Food preparation areas
- Lunch rooms
- Break rooms
- Food storage
- Public waiting areas
- Loading docks
- Waste handling areas/ bins/ compactors
- Utility rooms
- Outdoor storage areas
- Entry and exit doorways

During each site visit/inspection Pestec's service representative will input any deficiencies or pest sightings found and generate a list of "open" deficiencies that must be corrected by the Academy. On every subsequent visit the service rep. will either "close" the "open" deficiencies or confirm that the deficiencies have not been corrected. These unresolved deficiencies will be reported at the time of service. New deficiencies will be opened as they are found and followed-up as mentioned above. The visual inspection will be completed with the use of various inspections tools such as a flashlight, hand mirror,

stepladders, black lights, and probing tools. A digital photo will also be taken of the deficiency and sent to the IPM coordinator.

3. Indoor and outdoor monitoring/trapping devices consist of:

- Monitoring/trapping stations for rodents outdoors
- Ant bait stations
- Insect sticky traps
- Fly lights and sticky traps/ribbons
- Yellow jacket traps (for pre-season and peak season trapping)
- Indoor rodent trapping stations

The service representative will inspect all the monitoring devices on a quarterly basis with the devices in PPP's checked monthly. Pest activity findings will be recorded in the "Pest Activity Trends" sheet kept on-site in the logbook.

California Academy of Sciences Data Map and Pest Management Database

Pestec has completed a data map of every area and device inspected during regular services in the California Academy of Sciences. This map details the pest prone places in the Academy and the devices used to monitor for pests in areas throughout the building. All of this information is organized electronically into an accessible data map of the museum.

The data map is accessed via an electronic hand held device that runs software dedicated specifically to pest management. This software allows Pestec technicians to monitor pest populations over time, detail building deficiencies that are creating conditions conducive to pest populations and make recommendations to the Academy about the necessary steps administrators and employees can take to abate such conditions.

All of the information collected from each inspection is uploaded via this software to an online database that can be accessed by the Academy IPM Coordinator. Appendix B describes this online resource along with the data map and architectural maps of the areas and devices in the Academy.

IPM Action Table

In accordance with the framework of the San Francisco integrated pest management ordinance, each of the potential pest threats to the California Academy should be monitored; have an injury level determined; and treated in a manner consistent with the city's IPM ordinance. The IPM action table below lists the determinants of the injury level for pests commonly encountered in structural pest control, or what is also known as an action threshold: any associated pest activity which causes the injury level to increase to a degree where treatment is necessary.

In addition, the IPM action table provides a framework for responding to particular pest infestations. The actions taken by Pestec may vary depending on particular site circumstances and the concerns of stakeholders in pest management at a given site. The actions below are used as guidance when encountering a particular pest. The efficacy of the actions are tried and proven; however, each pest infestation provides Pestec new challenges and new opportunities to develop new methods of pest management not listed below.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
Rodents	**Level One (lowest): Rodent sighting, evidence of activity**	Use of non-toxic bait in exterior trapping stations, visual inspections and pest sighting reports.	Rodent sightings, evidence of rodent activity in trapping stations, interior traps, or other evidence of activity	1.) An IPM recommendation is generated for cleaning, clutter removal, interior and exterior rodent exclusion. 2.) Further visual inspection of the area to identify rodent travel areas and other areas of activity where trapping efforts can be initiated. 3.) Add traps to inconspicuous areas or in trapping stations. 4.) Review rodent proofing at outside envelope of the building.
Rodents	**Level Two: Rodent sighting(s), trapped rodents, new evidence of rodent activity**	Use of traps in exterior trapping stations, visual inspections and pest sighting	2+ rodents per trap/treatment station	1.) An IPM recommendation is generated for cleaning, clutter removal, interior and exterior rodent

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
		reports.		exclusion. 2.) Further visual inspection of the area to identify rodent travel areas and other areas of activity where trapping efforts can be initiated. 3.) Extra visits during daytime operations for follow-up and trap shuffle. 4.) Review rodent proofing at outside envelope of the building. 5.) Open inaccessible voids or areas such as the radiator covers along the windows in work areas for trapping.
Rodents	**Level Three (highest): Rodent sightings, trapped rodents, new accumulations of droppings or other evidence in multiple areas**	Use of traps in exterior trapping stations, visual inspections and pest sighting reports.	If 3+ rodents are removed from previous visit and rodent activity is noted on the next follow-up service.	1.) An IPM recommendation is generated for cleaning, clutter removal, interior and exterior rodent exclusion. 2.) Further visual inspection of the area to identify rodent travel areas and other areas of activity where trapping efforts can be initiated. 3.) Mass trapping service - traps are set throughout infested area after hours, and removed the following morning. Continue trapping until no further rodents are caught.
Cockroaches	**Level One (lowest): Aggregations of cockroaches local**	Visual inspections and pest	1+ Cockroach(es).	1.) An IPM recommendation is generated for cleaning,

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
	to a work area, kitchen workstation or equipment.	sighting reports.		clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area. 3.) Addition of sticky traps and bait station.
Cockroaches	**Level Two: Aggregations of cockroaches to more than one area in the kitchen, or work areas.**	Visual inspection, sticky traps and pest sighting reports.	2-4 Cockroaches per trap/treatment station.	1.) An IPM recommendation is generated for cleaning, clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Further placement of sticky traps and monitors with food attractant 4.) Crack and crevice gel bait application, and bait stations.
Cockroaches	**Level Three (highest): 4+ cockroaches per trap in any given location.**	Visual inspection, sticky traps and pest sighting reports.	4+ Cockroaches per trap/treatment station.	1.) An IPM recommendation is generated for cleaning, clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Steam treatment of cracks and crevices with vacuum clean up. 4.) Treatment of cockroaches with contact IPM detergent,

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
				OhYeah! 5.) Treatment of cracks and crevices with gel, granular bait and/or bait stations. 6.) Treatment with Gentrol Insect Growth Regulator (IGR).
Ants	**Level One (lowest): Aggregations of ants local to a work station, equipment, baseboards, windows, doors, restrooms and break rooms.**	Sticky traps, visual inspection, pest-sighting reports.	1-10 ants per room.	1.) An IPM recommendation is generated for cleaning, clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Treatment/clean-up of ants with contact IPM detergent, OhYeah! 4.) Spot caulking to minor cracks and crevices that ants may be traveling from.
Ants	**Level Two: Aggregations of ants local to a work station, equipment, baseboards, windows, doors, restrooms and break rooms.**	Sticky traps, visual inspection, pest-sighting reports.	Established ant trail	1.) An IPM recommendation is generated for cleaning, clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Treatment/clean-up of ants with contact IPM detergent, OhYeah! 4.) Placement of Advion or Terro ant bait station 5.) Spot caulking to

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
				minor cracks and crevices that ants may be traveling from.
Ants	**Level Three (highest): Aggregations of ants local to a work station, equipment, baseboards, windows, doors, restrooms, break rooms, hallways, lobby and walls.**	Sticky traps, visual inspection, pest-sighting reports.	Established and recurring ant trail and/or multiple trails	1.) An IPM recommendation is generated for cleaning, clutter removal, crack abatement and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Treatment of ants with contact IPM detergent, OhYeah! 4.) Placement of Advion and/or Terro ant bait station and/or crack and crevices application with Advion or Terro ant bait gel. 5.) Spot caulking to minor cracks and crevices that ants may be traveling from. 6.) Addition of exterior ant bait station(s) or outdoor crack and crevice gel bait treatment.
Flies	**Level One (lowest): Aggregations of flies local to exterior areas, trash room and compactor.**	Visual inspection, fly traps and pest sighting reports	Flies hovering near building entrance areas.	1.) An IPM recommendation is generated for cleaning, clutter removal, drain cleaning, areas conducive to and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Sanitation inspection

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
				and recommendations. 4.) Fly sticky traps.
Flies	**Level Two: Aggregations of flies local to work stations, entryways, restrooms, kitchens, and main floor.**	Visual inspection, fly traps and pest sighting reports	3+ flies	1.) An IPM recommendation is generated for cleaning, clutter removal, drain cleaning, areas conducive to and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Reinspect deficiencies and sanitation. 4.) Additional fly sticky traps, installation of electric fly traps at entrance areas.
Flies	**Level Three (highest): Aggregations of flies local to work stations, entry ways, restrooms, kitchens, and main floor.**	Visual inspection, fly traps and pest sighting reports	10+	1.) An IPM recommendation is generated for cleaning, clutter removal, drain cleaning, areas conducive to and/or moisture reduction. 2.) Further visual inspection of the area to identify the aggregation area(s). 3.) Reinspect deficiencies and sanitation. 4.) Clean up provided by Pestec at hourly service rate.
Bed bugs	**Level One: Bed bug activity sighted by staff.**	Sticky traps, visual inspection, monitoring stations, and pest activity	(1)	Immediate clean up of the area by staff or Pestec. Followed by K9 bed bug inspection and treatment as needed.

Pest	Threshold	Monitoring Method	Action Level	Pest Management Action(s)
		report		Inspection for cracks and crevices will also be conducted and recommendations for crack sealing made. Consultation with staff in work area and brief educational meeting or handout with assistance of staff manager.
Bed bugs	**Level Two: Bed bugs found in dense clutter.**	Sticky traps, visual inspection, monitoring stations, and pest activity report	(1 or more)	Triggers quarantine of clutter and thermal treatment of cluttered area. Consultation with staff in work area and brief educational meeting or handout with assistance of staff manager.
Bed bugs	**Level Three: Bed bugs found in multiple areas of a room with dense clutter**	Sticky traps, visual inspection, monitoring stations, and pest activity report.	Multiple bed bugs or recurring activity	All reported actions above and an extensive heat treatment of the infested space to insure the eradication of every level of the bed bug life cycle. Staff manager must take decision of whether, or when, a staff person with a bed bug infestation may return back to work.

12. Non-Chemical and Chemical Pest Control Methods for Key Structural Pests

This section describes recommended pest specific non-chemical (physical) and chemical controls and important information regarding biology and behavior for key pests at the California Academy of Sciences. The pests which normally pose problems for buildings in San Francisco are: rodents (mice and rats), ants, cockroaches, flies, pigeons, bed bugs, stinging insects (wasps, yellow jackets, bees) and arachnids. Each of these pests has a different recommended non-chemical and chemical controls associated with their management and abatement.

Mice

Management Objectives for Mice at the Academy

What does the Academy want/need to accomplish at the site in regard to the pest? The answer to this question depends on the customer. Some examples are:

- Reduce mouse complaints in the building and work with occupants to prevent future complaints.
- Work with the building manager or homeowner to prevent future mouse infestations.
- Help client comply with Health Department regulations.

House Mouse Identification

- They have a small, slender body reaching between 5 and 8 inches in length including the tail and weighing about a ½ ounce.
- They have a buff or light brown upper body that fades into a grey underside.
- The tail is naked, scaly and longer than the head and body
- The body itself is scantily haired with large ears and pointed nose, which distinguishes it from a young Norway rat, which has small ears, and a blunt nose.

Why the House Mouse is Considered a Pest

- Mice contaminate food and eating utensils.
- Mice can cause severe damage to research collections, living collections and exhibits.
- Mice can cause severe damage to structures from gnawing. They can cause fires, explosions, indoor flooding and damage to computer systems as a result of their gnawing on utility pipes and electrical wiring.

- Mice can carry a number of diseases. Hantavirus, a potentially lethal disease, is primarily carried and transmitted by the white-footed deer mouse.

Biology and Behavior of the House Mouse

To be successful, Management strategies must take into consideration the biology and behavior of the pest. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology

- The House mouse originated from the plains of central Asia and was transported on trade ships. With the exception of humans it is the most numerous and widespread mammal on Earth.
- Mice become sexually mature between 5 and 8 weeks old and have a sexual cycle of 4 days.
- House mice can breed yearlong. Outdoors mice are seasonal breeders, with peaks in spring and fall.
- A female produces between 4 and 7 pups per litter after a gestation period of about 20 days. The pups are born blind and naked but within 7 to 10 days they are covered with fur and their eyes and ears are open. Weaning takes place around 21 days.
- The average litter size for the House mouse is between 6 and 7 with up to 10 litters per year (depending on food availability). If conditions are right one female mouse can give birth to a litter every 24 to 28 days.
- A female House mouse will stop producing young after about 15 months, but she can live much longer.
- The lifespan of an average House mouse is 1 to 2 years. The maximum lifespan is 6 years.

Feeding Behavior

- The House mouse is very curious and will intensively investigate new objects or surroundings. They are constantly exploring new things near the nest and actively forage for food in a 10 ft. radius from the nest.
- Typically nocturnal animals, the House mouse will be most active after dusk and again right before sunrise. Indoors, mice may have period of active foraging during the day but will primarily forage about 30-60 minutes after human activity has ceased.
- The House mouse is typically omnivorous and opportunistic in its feeding. In the wild mice will forage on many types of plant seeds, but also snails, slugs and other insects. In and around buildings they will consume almost any readily available food but prefer cereals and grains.
- When water is abundant, the House mouse will consume 1 to 2 ounces per day. However, the House mouse is very adapted to going long periods with very little water, obtaining its water requirements from its food sources.

General Behavior

- Most established mouse populations inside buildings exist in groups of related individuals within which there is a high degree of social contact.
- These populations are territorial and defended by a single male.
- Like rats, mice will typically not cross open spaces with little or no cover and prefer to travel instead along walls and corridors with some cover.

Factors that favor the House Mouse

- Poor sanitation provides rats with ample quantities of food to sustain large numbers of mice.
- Improperly stored food and waste allows another food resource for mice populations to flourish on.
- Clutter and improper storage practices provide abundant hiding places, nesting sites, and travel routes for mice.
- Dense vegetation and ground cover can act as excellent nests and rodent highways.

Management Strategies for Mice

Pests need food, water and shelter to survive. Pests also need access to a structure and a way to move around within the structure in order to make them a nuisance inside a building. If even just one of these factors can be reduced (or eliminated), the environment will support lower pest numbers and pests will be less likely to invade our live/work spaces.

Habitat Modification

To limit availability of food and water

- Store food properly: in the refrigerator, in metal, glass, or heavy plastic containers with tight fitting lids.
- Do not leave food out overnight.
- Store bags of pet food, birdseed, and grass seed in rodent-proof containers, or at the very least, inspect them often for any signs of gnawing.
- Pick up fallen fruit and nuts from trees daily.
- Limit areas for eating and storing food and enforce these rules. The fewer designated areas, the easier it will be to limit pests.
- Fix leaky plumbing and eliminate any unnecessary standing water.
- Dispose of all garbage in dumpsters or garbage cans with tight fitting lids that are kept closed.
- Remove all garbage from the building at the end of the day
- Wash all garbage cans that contact food wastes with soap and water at least every 2 weeks.

- Require your refuse company to clean the dumpster or replace it with a clean one frequently.
- Never store extra garbage outside the dumpster or garbage cans, even if it is in cardboard boxes or plastic bags.

To limit availability of shelter/harborage

- Seal all openings in a structure that would allow access to the structure.
- Reduce clutter and debris by using proper storage techniques.
- Remove rock and woodpiles and construction debris.
- Trim trees, vines, bushes, grass, and weeds at least 2 feet from all buildings to decrease cover for rodent runways, to prevent hidden access to buildings and to make inspections easier.
- Trim tree and shrub branches 3 to 6 feet away from the building.
- Eliminate dense plantings or break them up with pathways, stretches of lawn, or very low groundcover.
- Avoid large expanses of low groundcover that could allow mice to run for long distances without being seen.

Physical Controls

Physical controls employ physical means to remove mice or prevent their access to or movement within a structure.

To prevent mouse entry:

- Trim trees and bushes at least 2 feet from the structure.
- Make general building repairs and seal large and small holes in structures both inside and out. Seal small holes with steel or copper wool and caulk.
- Seal vents with ¼ inch hardware cloth.
- Seal gaps where pipes and wiring enter the structure.
- Weather-strip doors and windows, use metal kick plates or raised metal doorsills to prevent rodent entry.
- Make sure air conditioning units are well sealed, especially those on the roof.
- Repair broken sewer pipes.
- Install threaded caps on drains.
- Use snap traps or glue boards and record their location on your site plan.
- Move objects around to funnel mice into traps.
- Monitor traps regularly and frequently, and keep bait fresh.

Chemical Controls

In general, chemical controls should be used as a last resort or in emergency situations. Rodenticides can pose hazards to children and non-target animals. Poisoned rodents may also die in inaccessible places and cause odor and fly problems. Overuse of many

rodenticides may also lead to widespread resistance. Exclusion methods are heavily preferred over any chemical means.

Roof and Norway Rats

Management Objectives for the Rats at the Academy

What does the Academy want/need to accomplish at the site in regard to the Roof or Norway rat? The answer to this question depends on the customer. Some examples are:

- Reduce rat complaints in the building and work with occupants to prevent future complaints
- Work with the building manager or homeowner to prevent future rat infestations
- Help client comply with Health Department regulations

Roof Rat Identification

- Scientific name is *Rattus rattus*
- Other common names include black, ship or house rat
- Adults weigh between 3 and 12 ounces
- They range in color from light brown to gray and black with a smooth coat
- They have large, thin, hairless ears and a pointed snout
- They are active climbers that prefer to nest inside in elevated areas such as attics and wall voids and outside trees and other vegetation
- Adults are decent swimmers

Norway Rat Identification

- Scientific name is *Rattus norvegicus*
- Other common names include brown, wharf or sewer rat
- Adults weigh between 3 and 21 ounces
- They are typically brown or black with a shaggy coat
- They have small, thick ears with short hairs and a blunt snout
- They are decent climbers which nest inside in walls and cluttered areas and outside in burrows or unused sewer or storm drains
- Adults are excellent swimmers

Why the Roof Rat and Norway Rat are Considered Pests

- Rats contaminate food and eating utensils
- Rats can cause substantial damage to research collections, living collections and exhibits.
- Rats can cause damage to structures by gnawing on doors, walls, ceilings and floors. They cause fires, explosions, indoor flooding, and damage to computer systems as a result of their gnawing on utility pipes and electrical wiring.

- Rats have the potential to carry a number of harmful diseases
- They can also carry tropical rat mites that can bite humans and cause serious annoyance

Biology and Behavior of the Roof and Norway Rat

To be successful, management strategies must take into consideration the biology and behavior of the pest. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology of the Roof and Norway Rat

- Adults are polyestrous (multiple breeding cycles), breeding every 4 to 5 days. In subtropical climates rats can reproduce year round. In cooler climates populations peak in spring and fall.
- The average litter size is between 5 and 12.
- They can have up to 9 litters per year depending on food availability. Roof rats have an average of 5 litters per year while the Norway rat has an average of 4 litters per year.
- The gestation period is 20-25 days.
- It takes around 30 days for weaning
- The Norway rat takes 75-90 days to reach sexual maturity while the Roof rat takes between 68 and 90 days.
- They have poor eyesight, but an excellent sense of smell, taste, touch and hearing.
- Rats have highly sensitive body hairs and whiskers (called vibrissae) that help them navigate
- Lifespan is generally under 1 year.

Feeding Behavior

- Usually search for food between dusk and dark
- Rats feed on all kinds of human and pet food.
- Roof rats prefer fresh plan material such as fruits, vegetables, nuts, seeds and tree bark. They are frequently associated with avocado and citrus trees. Roof rats will also eat insects, slugs and snails.
- Norway rats prefer foods high in carbohydrates or protein but will eat almost anything including non-food items such as soap.

General Behavior

- Rats are mainly nocturnal, but can be seen during the day if colonies are overpopulated.
- They prefer to travel along edges, along pipes or rafters, along the outside or inside of a foundation and for roof rats, along overhead utility lines.

- Rats are generally wary of crossing open spaces that provide no cover. Hedges and other dense vegetation in landscaping or against buildings provide cover for rodent trails.
- Rats are usually extremely wary of new objects in their environment; however this is only a temporary hesitation.
- Rats can fit through openings the size of a dime.
- They also have amazing physical abilities that allow them to climb vertically in pipes, walk horizontally along wires, and jump from a standstill vertically at least 24 inches and horizontally at least 4 feet. They can also drop from heights of 50 feet without injury.
- All rats can swim. The Norway rat in particular is an excellent swimmer, which can swim a half-mile in open water and tread water for up to 3 days. They have also been known to swim up through the water seal of a toilet.
- Rats will gnaw through almost any material with an exposed edge including, wood, chip board, lead pipes, cinder blocks, aluminum, sheet metal and glass.

Factors that favor the Roof and Norway Rat

- Poor sanitation provides rats with ample quantities of food to sustain large numbers of rats.
- Improperly stored food and waste allows another food resource for rat populations to flourish on. Pet foods are a common meal for rats and should be stored properly as well.
- Clutter and improper storage practices provide abundant hiding places, nesting sites, and travel routes for rats.
- Dense vegetation and ground cover can act as excellent nests and rat highways.

Management Strategies

Pests need food, water and shelter to survive. Pests also need access to a structure and a way to move around within the structure in order to make them a nuisance inside a building. If even just one of these factors can be reduced (or eliminated), the environment will support lower pests and pests will be less likely to invade our living spaces.

Habitat Modification

To limit availability of food and water:

- Store food properly: in the refrigerator, in metal, glass, or heavy plastic containers with tight fitting lids.
- Do not leave food out overnight.
- Store bags of pet food, birdseed, and grass seed in rodent-proof containers, or at the very least, inspect them often for any signs of gnawing.
- Pick up fallen fruit and nuts from trees daily.
- Pick up animal droppings daily.

- Never leave food for animals in living collections exposed or uncontained food inside or outdoors for any length of time.
- Limit areas for eating and storing food and enforce these rules. The fewer designated areas, the easier it will be to limit pests.
- Fix leaky plumbing and eliminate any unnecessary standing water.
- Dispose of all garbage in dumpsters or garbage cans with tight fitting lids that are kept closed.
- Remove all garbage from the building at the end of the day
- Wash all garbage cans that contact food wastes with soap and water at least every 2 weeks.
- Require your refuse company to clean the dumpster or replace it with a clean one frequently.
- Never store extra garbage outside the dumpster or garbage cans, even if it is in cardboard boxes or plastic bags.
- Avoid planting date palms because rats can feed on and nest in these trees.

To limit availability of shelter/harborage:

- Seal all openings in a structure that would allow access to the structure.
- Reduce clutter and debris by using proper storage techniques.
- Remove rock and woodpiles and construction debris.
- In warehouses and commercial storage areas, store items on pallets 12 inches off the floor in rows 6 feet wide or less, and at least 18 inches from any wall. This creates aisles for inspection and cleaning.
- Trim trees, vines, bushes, grass, and weeds at least 2 feet from all buildings to decrease cover for rodent runways, to prevent hidden access to buildings and to make inspections easier.
- Trim tree and shrub branches 3 to 6 feet away from the building.
- Eliminate dense plantings or break them up with pathways, stretches of lawn, or very low groundcover.
- Avoid large expanses of low groundcover that could allow rats to run for long distances without being seen.
- Eliminate plantings of Algerian ivy (Hedera canariensis) because rats can live in and feed on this ivy. If you cannot eliminate these plantings, work toward that goal. And in the meantime, mow or shear the ivy very close to the ground.

Physical Controls

Physical controls employ physical means to remove rats or prevent their access to or movement within a structure.

To prevent rat entry:

- Trim trees and bushes at least 2 feet from the structure.
- Make general building repairs and seal large and small holes in structures both inside and out. Seal small holes with steel or copper wool and caulk.
- Seal vents with ¼ inch hardware cloth.

- Seal gaps where pipes and wiring enter the structure.
- Weather-strip doors and windows, use metal kick plates or raised metal doorsills to prevent rodent entry.
- Make sure air conditioning units are well sealed, especially those on the roof.
- Repair broken sewer pipes.
- Install threaded caps on drains.
- Use snap traps or glue boards and record their location on your site plan.
- Use as bait the food rats are already eating or for Roof rats use nuts, dried fruit, apples, bananas, candy, marshmallows, raisins or peanut butter. For Norway rats use pieces of hot dog, bacon, liver, peanut butter, or nutmeats.
- Move objects around to funnel rats into traps.
- Monitor traps regularly and frequently, and keep bait fresh. Rats avoid old or rancid bait.

Chemical Controls

In general, chemical controls should be used as a last resort or in emergency situations. Rodenticides can pose hazards to non-target animals and children. Poisoned rodents may also die in inaccessible places and cause odor and fly problems. Overuse of many rodenticides has lead to widespread resistance. Exclusion methods are favored over any chemical means.

Ants

Management Objectives for Ants at the Academy

What does the Academy want/need to accomplish at the site in regard to the Argentine Ant? The answer to this question depends on the customer. Some examples are:

- Reduce ant complaints in the building and work with occupants to prevent future invasions
- Keep ants out of computer room and educate computer techs on why ants invade
- Pull ants out of building; reduce possibility of future invasions by educating building occupants and reducing the ideal habitat that currently exists next to the building.
- Minimize ant impact on the living collection and food offerings for the living collection
- Minimize ant impact on pest control measures in indoor plantscapes.

Why Ants are Considered Pests

- Ants are mainly nuisance pests that trail into buildings in search of food or nesting sites.
- Some ants such as Argentine Ants can exacerbate pest infestations in planted collections by actively protecting pests and spreading them throughout plantings.
- Ants can invade and infest food offerings for live animal exhibits.

- Ants do not sting.
- Occasionally they may bite, but the bite is a mild pinch.
- Typically ants are not vectors for any diseases.

Argentine Ant Identification

- Workers are all the same size, around 1/8 inch long
- Uniformly dull brown in color Single Node
- Petiole with 1 erect node
- Thorax is uneven, not smooth, when viewed from the side
- If a single ant is crushed, it has little smell
- If a large number of ants are crushed, they have a musty smell.
- The smell of an Argentine ant is very different from the rotten coconut odor of an odorous house ant.

Biology and Behavior of the Argentine Ant

To be successful, management strategies must take into consideration the biology and behavior of the pest. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology

- The Argentine ant is not native to the U.S. It probably came on Brazilian coffee ships to New Orleans in the late 1800's.
- In 1918, J.R. Horton wrote in a USDA Bulletin that he and his colleagues had trapped 1.3 million Argentine queens and collected 1,000 gallons of brood.
- This ant was first found in California in 1905, in Ontario. By 1908 it had spread through the citrus growing regions of the state to San Francisco.
- In the most urbanized areas of California, the Argentine ant has replaced all native ants.
- Argentine ants may be capable of carrying pathogenic bacteria in hospitals and food establishments.
- Ants have 4 life stages: egg, larva, pupa (cocoon), and adult. Queens lay eggs that hatch into small larvae. The larvae grow as the adult worker ants, which are all female, feed them. When the larvae are grown, they change into pupae. During the pupal stage, the pupa changes into an adult ant.

Argentine Ant Colonies

- Tunnels link Colonies; workers and queens move freely from nest to nest; each colony has many queens that live in harmony. Perhaps it is more accurate to think of Argentine ants as living in huge colonies with 1000's of entrances.
- Because of these huge "super colonies," the concept of finding and killing "the" nest is not always valid.

- The energy that most other ant species use in defending the colony is used instead for reproduction.

Feeding Behavior

- Adult worker ants (all females) feed and care for the young, but also feed each other and the queens.
- Up to 50% of the food workers ingest is shared with fellow workers. The technical term for insects exchanging food with one another is trophallaxis. This is the way baits are spread throughout a colony.
- Adult ants feed only on liquids, but they collect solid food for larvae (the immature stage) living in the nest. Larvae digest the solid food and produce liquids for the workers to feed on.
- On average at any one time, a very small proportion of a colony is out foraging for food; so killing these ants will not eliminate the colony.
- Argentine ants will forage 200 ft. away from their nest.
- Argentine ants feed on just about anything from dead animals (including insects) to all kinds of human and pet food.
- A favorite food is the honeydew produced by insects like aphids, mealy bugs, scales, and whiteflies. Argentine ants protect these insects from their natural enemies.
- Plants that harbor these pests and are growing near a structure will attract ants to the building.
- If ants are excluded from plants with honeydew-producing insects, natural enemies will often eliminate the plant pests.

Liquid baits with sugar as the attractant are useful throughout the year, because adult ants will always feed on sugary liquids. Baits with a protein attractant may only be useful when the colony is expanding and ants are feeding a large number of young.

Seasonal Development of the Colony and Baits Likely to be Taken Each Season

Seasonal Ant Baiting		
Season	**Seasonal ant description**	**Baiting technique**
Winter (November through January)	In winter, many adults die and the colony essentially stop breeding. The ant population is small.	Liquid sugar baits are accepted better than other baits. Less is needed due to the lower population.
Late Winter/early Spring	In late winter and early spring, breeding increases and adult workers seek honeydew producing insects (aphids, scales, mealy bugs, and whiteflies) and protein to feed developing larvae	Both solid protein and liquid sugar baits are accepted.
Summer	Honeydew producing insects decline (beginning in July/August), and ants start to look elsewhere for food, often in nearby buildings.	In early summer, solid protein baits are still accepted. Liquid sugar baits are readily accepted all summer.
Fall	The ant population has reached its maximum, honeydew food sources have declined and foraging pressure results in more nearby building invasions.	Sugar baits readily accepted.

Nesting Sites

- Argentine ants move their colonies within hours to take advantage of a food source or to escape inhospitable conditions. In winter they look for places that are warmer and drier, and in summer they seek cooler and moister sites.
- Their shallow nests are primarily in the ground, and significant soil mounds do not mark them. They prefer moist, well-drained soil.

Outside, ants nest

- Near irrigated turf and other landscaping
- In planters and potted plants
- In the ground under trees, especially trees with honeydew producing insects,
- Near faucets and irrigation valves
- Under sidewalks, stones and patios
- In soil accumulated in the corners of a roof

Inside, ants nest

- In potted plants
- Inside cupboards and drawers

- Under tiles on kitchen counters, behind wall tile and brick veneer
- In the insulation in dishwashers, washing machines, and refrigerators,
- In wall voids, in moist basements, and in vehicles
- In unusual places such as inside metal curtain rods

Landscape factors that favor the Argentine ant:

- Damp and/or disturbed soil
- Soil in potted plants
- Mulch such as shredded bark, pebbles, small stones
- Vegetation that supports honeydew-producing insects such as citrus, pines, bottlebrush, birch
- Soil that is kept warm by the thermal mass of a sidewalk, flagstone walk or patio, decorative rock on top of black plastic

Management Strategies for Ants

Pests need food, water, and shelter to survive. Pests also need access to a structure to make themselves nuisances inside a building. If even just one of these factors can be reduced (or eliminated), the environment will support fewer pests, and pests will be less likely to invade our living spaces.

Habitat Modification

To limit availability of food outdoors:

- Ensure all food intended for live animal exhibits are contained in exhibits or approved storage containers at all times.
- Consider placing barriers such as tangle foot or water moats to prevent ant access to feeding stations in ant-infested exhibits.
- Thoroughly rinse recyclables that will be stored outdoors.
- Store garbage, especially garbage containing food wastes, in garbage cans or dumpsters outside the building.
- Treat honeydew-producing insects on vegetation near the structure by washing with plain water. Aphids, scales, mealy bugs, whiteflies, and psyllids are examples of honeydew-producing insects.

Some plants that are highly attractive to honeydew-producing insects are:

- Citrus
- Bottlebrush bush
- Chinese elm
- Conifers (pines, redwoods)
- Eugenia
- Figs
- London Plane tree (sycamore)

- Pittosporum
- Roses

Exclusion Methods

- Use sticky barriers around trunks to exclude ants, and trim branches that touch the building, the ground, other plants or structures to prevent ants from finding an alternative route into the plant.
- Remove and/or replace plants that regularly have large populations of honeydew-producing insects.

To limit availability of shelter/habitat outdoors:

- Reduce excessive moisture and irrigation leaks near structures.
- Reduce areas covered with black plastic and decorative rock, especially next to the foundation.
- Reduce or eliminate bark mulch close to the structure.
- Cut back or eliminate ground covers next to the structure. This will also allow Pestec to have access to the foundation to observe ant activity.

To limit availability of food indoors:

- Thoroughly clean food preparation and eating areas daily.
- Discuss importance of sanitation with appropriate people
- Regularly steam clean large appliances in commercial kitchens.
- Store food in the refrigerator, freezer, or cooler, or in ant-proof containers such as Tupperware or screw top jars (screw-top jars are not ant-proof unless the lid has a rubber gasket).
- Use plastic liners in wastebaskets and garbage cans
- Remove garbage containing food wastes from building before nightfall or tie a knot in the plastic liner.
- Set small garbage cans on ant-proof stands such as the Antser® (platform with soapy water moat underneath)
- Wash pet bowls immediately after pets have eaten or place pet dishes on ant-proof stands such as the Antser®(platform with soapy water moat underneath).
- Store food for live animals in pest-proof containers.

To limit availability of shelter/habitat inside:

- Remove potted plants with ant nests
- Place potted plants on ant-proof stands such as the Antser® (platform with soapy water moat underneath)
- Place potted plants in a moat of soapy water: place plant on a small overturned saucer inside a larger saucer; add water to the larger saucer along with several drops of liquid detergent.

Physical Controls

Physical controls employ physical means to remove ants or prevent their access to a structure.

To remove ants inside and outdoors:

- Vacuum up ant trails.
- Pick up ants with a sticky lint roller
- Clean up ant trails with soap and water

Outdoors: To limit access to the structure (pest-proofing):

- Trim trees and bushes touching the structure
- Caulk or otherwise seal entry points where ants are getting in or have been seen getting in, especially around plumbing and wiring. Not all holes in a structure need to be sealed to make a difference in the number of ant invasions.

Inside: To limit access to the structure (pest-proofing):

- Caulk or otherwise seal entry points that ants are currently using or that are nearby. Not all holes in a structure need to be sealed to make a difference in the number of ant invasions.
- Insert foam insulator sheets behind electrical faceplates to seal off ant access and reduce infiltration of hot or cold air.
- Blow low-toxic insecticidal dusts into cracks and wall voids

Chemical Controls

Chemical controls are used to directly suppress the ant population; however, with Argentine ants, it will never be possible to eradicate them from any particular area. There are too many ants nearby that will simply move in to fill the empty habitat. The goal of ant management is to prevent the ants from becoming a nuisance to the people living and working in a structure.

Baiting is the preferred chemical control method for ants outdoors.

Why use baits?

- Baiting may take longer to kill ants, but will have a much greater impact on the colony as a whole, because ants take bait back to feed to their nest mates. Sprays kill only a small fraction of the ants that are out foraging, and the foragers only represent a very small fraction of the total colony.
- Spraying pesticides around the outside of a structure can lead to run-off that contaminates creeks, rivers, and the Bay.
- Baits are used outdoors to draw ants out of a structure.

Inside, baiting is also the preferred chemical control method for ants.

Inside, baits will be left only long enough to stop the trail of ants entering the building. At that point the bait stations will be removed in order not to attract more ants.
Note: Do not spray pesticide on or near ant bait stations because the pesticide will repel the ants.

If ant populations are high, or invasions persist, and placing a bait station at the exterior perimeter of the building is not feasible, a low-toxic and/or repellent insecticidal dust will be applied to cracks, crevices, wall voids, electrical boxes, conduits, etc. If necessary, insecticidal dusts will be used to spot-treat under the edge of carpets and behind baseboards.

Cockroaches

Management Objectives for Cockroaches at the Academy

What does the Academy want/need to accomplish at the site in regard to cockroaches? The answer to this question depends on the customer. Some examples are:

- Reduce cockroach complaints in the building and work with occupants to prevent future complaints
- Keep the number of cockroaches caught in sticky insect monitors at a certain level
- Help client comply with Health Department regulations

Cockroach Identification

German Cockroaches

- Adults are pale to medium brown and about ½ to 5/8 inch long.
- Adults have 2 dark stripes running parallel to the body on the upper surface of the first segment of the thorax (called the "pronotum").
- The young are smaller and darker than the adults.
- The most prominent marking on a young German cockroach is a single light stripe running down the middle of the back.
- Adults have wings, and young have varying sizes of wing buds.
- Adult females carry their egg capsule (called the "ootheca") protruding from the rear of their abdomen until about a day before it is ready to hatch.
- The egg capsule is about 1/3 inch long and contains between 30 and 48 eggs.

Australian and American Cockroaches

- American cockroaches are the largest roach to typically invade structures. Adults are 1.5-2" long.

- American cockroaches are reddish brown in color, with yellowish band behind the head. Juveniles are smaller and but similar in color and have varying sizes of wing buds.
- Australian cockroaches are somewhat smaller with adults at 1.25”
- Adult Australian cockroaches are reddish brown with distinctive yellow rimmed “mask” on the head. Juveniles have distinctive yellow stripes on the thorax and abdomen and have varying sizes of wing buds.
- Egg cases of both are reddish brown, approximately ¾’ long and capsule shaped. Australian cockroaches typically attach their egg cases to solid vertical surfaces.

Why Cockroaches are Considered Pests

- Cockroaches contaminate food and eating utensils.
- Cockroaches can damage research collections.
- Cockroaches can infest living collections and damage animals and plants.
- In general, cockroaches are not associated with severe illnesses or disease outbreaks, but cockroaches can transmit organisms that cause gastro-intestinal distress and food poisoning as they wander over food and utensils.
- Cockroaches are a source of allergens that can trigger life-threatening asthma attacks in some people.
- They can destroy fabric and paper products.
- Most people are disgusted by the thought or the actual presence of cockroaches.

Biology and Behavior of Cockroaches

To be successful, management strategies must take into consideration the biology and behavior of the pest. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology of the German Cockroach (*Blattella germanica*)

The German cockroach is native to a warm, moist climate, probably tropical Africa, and is now found in every state in the U.S.

The German cockroach is unable to survive away from the warm, moist, food-rich habitats provided by humans inside buildings and other structures.

- German cockroaches have 3 distinct life stages: egg, nymph, and adult.
- Adult females carry the egg capsule around with them until about a day before it is ready to hatch. This increases the chances of more of the young surviving.
- The egg capsule hatches into many tiny nymphs that resemble the adults but are smaller, without wings, and cannot reproduce.
- The nymphs molt (shed their skins and grow a small amount) 5 to 7 times, depending on the temperature and availability of food and water, before reaching adulthood.

- The process from egg to adult takes around 100 days, again depending on the temperature and availability of food and water.
- It has a greater number of eggs per egg capsule than other species that infest buildings
- It takes the shortest time to develop from egg to sexually mature adult
- This means that the numbers of German cockroaches in an area can build up rapidly
- Their high reproductive potential allows German cockroaches to become resistant to pesticides more quickly.
- German cockroaches are smaller than other species and therefore can find many more hiding places in the same amount of space.

Feeding Behavior

- The German cockroach avoids light and usually does most of its foraging for food 3 hours before dark and 1 hour before it gets light. However, cockroaches can learn different foraging schedules in order to avoid human activity.
- The German cockroach will eat almost anything, including its fellow cockroaches and their droppings.
- For survival, water is much more critical to the German cockroach than food. If water is present, the adults can live for weeks without food.
- In the absence of both food and water, adults die in less than 2 weeks.

General Behavior

- The German cockroach prefers hiding in tight or narrow spaces especially where it is warm and moist. Kitchens, bathrooms and electrical equipment are favorite places. Clutter vastly increases the amount of harborage available. Attractive harborage includes
- Cracks and crevices in walls, floors, cabinets, furniture and appliances
- Inside the corrugations of cardboard
- Within stacks of newspaper or paper bags
- Younger stages of nymphs and females carrying egg capsules are more likely to stay close to their harborage when looking for food.
- Older nymphs and adults will search more widely for food.

Factors that favor the German Cockroach

- Poor sanitation provides large quantities of food for cockroaches and makes them less likely to feed on poison baits. . Leaks and other sources of moisture provide cockroaches with abundant water.
- Clutter provides abundant hiding places for cockroaches.
- Poor building maintenance can provide cockroaches with access to structures, harborage, water, and easy pathways from room to room within the structure.
- Little or no inspection of goods coming into the structure can allow cockroaches to hitchhike into the building.

General Biology of American (*Periplaneta americana*) and Australian (*Periplaneta australasiae*) cockroaches

- American cockroaches is native to a warm, moist climate, probably tropical Africa. The Australian cockroaches are also native to warm tropical climate, possibly originating in Asia.
- Both species are unable to survive away from the warm, moist, food-rich habitats provided by humans inside buildings and other structures.
- American cockroaches are able to establish in indoor structures in temperate areas where Australian cockroaches are typically limited to greenhouses and tropical exhibits.
- Cockroaches have 3 distinct life stages: egg, nymph, and adult.
- Australian and American cockroaches drop egg cases shortly after they are formed, near food source in crevices, on walls or under moist wood to camouflage. Incubation is 30-50 days
- The egg capsule hatches into many(12-30) tiny nymphs that resemble the adults but are smaller, without wings, and cannot reproduce.
- The nymphs molt (shed their skins and grow a small amount) several times, depending on the temperature and availability of food and water, before reaching adulthood.
- Australian cockroaches reach adult stage in 6-12 months, American cockroaches in ~400 days on average.
- Adult life span for American cockroaches is up to 2 years and females produce 6-90 egg cases in a life time.
- Adult Australian cockroaches live up to 8 months and females produce 12-30 egg cases in a lifetime at about 10 day intervals.

Feeding Behavior

- Australian and American cockroaches avoids light and usually do most foraging for food 3 hours before dark and 1 hour before it gets light. However, cockroaches can learn different foraging schedules in order to avoid human activity.
- Both are omnivorous scavengers but Australian cockroaches prefer decaying organic vegetable matter.
- For survival, water is much more critical to the American cockroach than food. If water is present, the adults can live 2-3 months without food.

General Behavior

- The both species of cockroaches prefer hiding in tight or narrow spaces especially where it is warm and moist. Kitchens, bathrooms and electrical equipment are favorite places. Clutter and organic debris vastly increase the amount of harborage available. Attractive harborage includes:
- Cracks and crevices in walls, floors, cabinets, furniture and appliances
- Inside the corrugations of cardboard
- Within stacks of newspaper or paper bags

- Tropical plantings and live animal exhibits with organic decor
- Younger stages of nymphs and females carrying egg capsules are more likely to stay close to their harborage when looking for food.
- Older nymphs and adults will search more widely for food.

Factors that favor American and Australian Cockroaches

- Poor sanitation provides large quantities of food for cockroaches and makes them less likely to feed on poison baits. . Leaks and other sources of moisture provide cockroaches with abundant water.
- Clutter provides abundant hiding places for cockroaches.
- Poor building maintenance can provide cockroaches with access to structures, harborage, water, and easy pathways from room to room within the structure.
- Little or no inspection of goods coming into the structure can allow cockroaches to hitchhike into the building.
- Tropical environments favor Australian cockroaches. Organic debris in planted exhibits and live animal exhibits can provide habitat for extensive populations
- Food offerings for exhibit animals that are accessible to cockroaches.

Management Strategies for Cockroaches

Pests need food, water, and shelter to survive. Pests also need access to a structure and a way to move around within the structure in order to make them a nuisance inside a building. If even just one of these factors can be reduced (or eliminated), the environment will support fewer pests, and pests will be less likely to invade our living spaces.

Habitat Modification

To limit availability of food and water:

- Food preparation and eating areas should be thoroughly cleaned daily. Drain sinks and remove all food debris. Do not leave food prep and eating areas dirty over night.
- Discuss the importance of sanitation with the appropriate people.
- Regularly steam clean large appliances in commercial kitchens.
- Periodically give all food preparation areas a deep cleaning focusing on drains, vents, deep fat fryers, ovens, and stoves. Steam clean drains and infested appliances. Use a vacuum cleaner to capture cockroaches driven out by the steam.
- Use plastic liners in waste receptacles Food offerings for collection animals should be contained in exhibits and terrariums at all times.
- Remove garbage containing food wastes from the building before nightfall or tie a knot in the plastic liner.
- Store garbage in closed, rodent-proof dumpsters or garbage cans outside the building.
- Keep waste receptacles and dumpsters clean.

- Clean cans, bottles, and other recyclables before storage and remove them from the building before nightfall.
- Store food in the refrigerator, freezer, or cooler, or in roach-proof containers such as Tupperware or screw top jars (screw-top jars are not roach-proof unless the lid has a rubber gasket).
- Store food for animal collections in roach-proof containers.
- Discourage people from storing food in desks or lockers. Insist that food in personal spaces is stored in roach-proof containers.
- Limit areas where food can be eaten and make sure to clean those areas after holiday, birthday, or other kinds of parties.
- Fix all leaking faucets and pipes.
- Drain and/or ventilate moist areas.
- Keep food preparation areas dry when not in use, especially over night.

To limit availability of shelter/harborage:

- As much as possible, eliminate clutter
- Break down corrugated cardboard boxes and store them away from vending machines and food storage and preparation areas, preferably in a cool or cold spot.
- Keep storage closets and other storage areas well organized and clean.
- Remove excess items that result in clutter.
- Caulk or otherwise seal cracks and crevices, first in areas where cockroach populations are highest. As time and money allow, work on other areas that provide good cockroach harborage.
- If gaps cannot be sealed, they can sometimes be widened to make them unattractive to cockroaches. For instance, moving the shelves one inch away from the walls can widen the space between freestanding shelves and adjacent walls.
- Where possible limit organic debris in indoor planted areas.

Physical Controls

Physical controls employ physical means to remove cockroaches or prevent their movement within a structure.

- Sticky insect monitors are moderately effective in capturing cockroaches, but they usually cannot solve a cockroach problem by themselves.
- Vacuuming has an immediate impact on the cockroach population and reduces the level of allergens.
- Sealing gaps in walls around plumbing and electrical conduit is very important to keep cockroaches from moving along these “roach highways” from one room to another.
- Foam insulator sheets inserted behind electrical faceplates will seal off cockroach access and reduce infiltration of hot or cold air.

- Screening and weather-stripping windows and doors can prevent cockroaches from walking out of a window or door and moving up or down the outside of a building to get to another floor.
- Inspect new plants for cockroaches in the soil or root ball.

Chemical Controls

Chemical controls are used to directly suppress a cockroach population.

- Dusting Agents (Note that these can remain effective for very long periods of time as long as they don't get wet.)
- Diatomaceous earth works by absorbing the outer waxy coating on an insect's body, which allows water to leak out of the insect, and causes death by dehydration. Diatomaceous earth can be used in wall voids, cracks and crevices, and under appliances.
- Insect Growth Regulators (IGRs). IGRs do not kill cockroaches directly. They cause immature cockroaches to become sterile adults that die without reproducing. Affected cockroaches often have twisted wings.
- Cockroach Baits: Baits work best where sanitation is good so that the bait is not competing with freely available Cockroach food. Using baits reduces the amount of pesticide in the environment because small amounts of bait, containing minute amounts of pesticide, are placed only in areas where cockroaches are likely to feed.

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Flies

Management Objectives for Flies at the Academy

What does the Academy want/need to accomplish in regard to flies? The answer to this question depends on the customer. Some examples are:

- Reduce fly complaints in the building and work with occupants to prevent future complaints
- Keep flies out of food handling and food processing areas
- Help customer comply with Health Department regulations

Fly Identification

All flies have only 2 wings. The larvae (maggots) of house, flesh, and blow flies are very similar: legless, round in cross-section, tapered at the front end and blunt at the hind end, cream to yellowish in color.

Important Garbage- and Manure-Breeding Flies

Fly Identifying Characteristics and Preferred Host Material

Name	Identifying characteristics	Preferred host material
House fly (*Musca domestica*)	Long; dull gray with 4 dark stripes on thorax; 4th wing vein sharply angled	Animal waste, garbage, piles of lawn clippings, and other decaying organic matter
Flesh flies (*Sarcophaga spp*.)	2 to 3 times larger than house fly; 3 dark stripes on thorax, gray and black checkerboard pattern on the abdomen	Garbage, pet droppings, animal manure, and animal carcasses
Blow flies or Bottle flies (Family *Calliphoridae*)	About twice as large as house fly; no stripes on thorax; metallic blue, green, or bronze in color	Animal carcasses, animal wounds, garbage, pet droppings, and animal manure
Fruit Flies *Drosophila melanogaster*	Tan and black with red eyes approximately 1/8" long	Ripened, fermenting and rotting fruit.

Adapted from M.C. Wilson, G.W. Bennett, and A. V. Provonsha, *Practical Insect Pest Management: Insects of Man's Household and Health* (Prospect Heights, IL: Waveland Press, 1977); with reference to the University of Kentucky Entomology Department page on Fruit Flies: http://www.ca.uky.edu/entomology/entfacts/ef621.asp .

Why Flies are Considered Pests

- Flies contaminate food, eating utensils, food preparation surfaces.
- Flies are associated with many disease-causing organisms and their habits make them efficient mechanical vectors of these organisms.
- Their constant presence can be extremely annoying.

Special Regulatory Conditions

California Health and Safety Code Sections that relate to flies and cleanliness in food establishments:

- 114010. "All food shall be prepared, stored, displayed, dispensed, placed, transported, sold, and served as to be protected from dirt, vermin, unnecessary handling, droplet contamination, overhead leakage, or other contamination."
- 114030. "A food facility shall at all times be so constructed, equipped, maintained, and operated as to prevent the entrance and harborage of animals, birds, and vermin, including, but not limited to, rodents and insects."
- 114040. "The premises of each food facility shall be kept clean and free of litter, rubbish, and vermin."
- 114050. "All food facilities and all equipment, utensils, and facilities shall be kept clean, fully operative, and in good repair."

Biology and Behavior

To be successful, Management strategies must take into consideration the biology and behavior of the pest. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology of the House Fly (*Musca domestica*)

All flies have 4 distinct life stages: egg, larva (commonly called maggot), pupa, and adult.

- An adult female house fly lays batches of 75 to 100 tiny, white, oval eggs in organic material suitable for larvae to feed on (see below).
- In warm weather, the eggs can hatch in one day
- When the maggots are ready to pupate, they move to the drier portions of the material they have been living in, or they may crawl quite a distance to pupate in loose material, under boards, stones, etc.
- In warm weather, the house fly can grow from egg to adult in as little as 8 days.
- House flies can fly as far as 20 miles, but in general they do not move more than 1 or 2 miles.

Feeding Behavior of the House Fly

- Adult house flies have sponging mouthparts that only allow them to eat liquids. Some solid foods can be liquefied with regurgitated saliva and then sponged up through the mouthparts.
- While feeding, flies also defecate on their food.
- Adults are attracted to a wide variety of food materials.
- Larvae feed on decaying organic matter such as
- Animal manure or droppings
- Wet garbage
- Piles of lawn clippings
- Decaying vegetables or fruits
- Soil contaminated with any of the above

General Behavior of the House Fly

- Wherever house flies rest, they leave "fly specks", light brown/cream-colors specks of saliva and excrement that are a strong attractant for other house flies.
- For resting places during the day or night, house flies prefer corners, edges, and thin objects such as wires and strings, but can be found surfaces such as walls, ceilings, floors, the ground, plants, garbage cans, and fences.

General Biology and Behavior of the Little House Fly (*Fannia canicularis*)

- *Fannia* is smaller and more slender than the house fly and the 4th wing vein continues directly to the edge of the wing rather than being sharply angled as it is in the house fly.
- *Fannia* breeds in manure from dogs, poultry, horses, cows, and humans as well as decaying vegetable matter.
- Males of this species are often found flying in circles in the middle of a room, on a porch, or in a shaded area outdoors.
- Females are rarely found indoors.
- Larvae are brown, flattened, and have fleshy spines on their backs and sides.
- Larvae can tolerate a wide range of moisture in their habitat.
- This fly appears earlier in the spring than the house fly and disappears in the summer in areas with high temperatures.
- Adults are attracted to honeydew and can be found swarming under plants infested with aphids.
- These flies take from 18 to 22 days to grow from egg to adult.

General Biology and Behavior of Flesh Flies (*Sarcophaga spp*.)

- These flies are associated with small dead animals—insects and snails as well as small vertebrates (animals with backbones).
- Only a few species breed in larger animal carcasses.

- At least one species (Sarcophaga destructor) can develop entirely on decomposing vegetable matter.
- Around the home, these flies are attracted to garbage and compost piles.

General Biology and Behavior of Blow Flies (Family *Calliphoridae*)

- Adults make a loud droning buzz.
- Adults are attracted to dead animals, animal wounds, bloody or feces-caked hair or wool on pets or farm animals, and wet garbage.
- Birds or rodents that die in walls or chimneys can produce large numbers of blow flies.
- Green bottle flies can be found on dog droppings
- These flies require 15 or more days to develop from egg to adult.
- Flight range is 3 to 10 miles

General Biology and Behavior of Fruit Flies (*drosophila melanogaster*)

- Adults can live from two weeks to 30 days.
- Female's can lay up to 500 eggs.
- Red eyes, black and tan bodies
- Prefer to breed in ripened, fermenting or spoiled produce.
- Fruit flies are drawn to any residual food sources.

Factors that favor Flies

- Improperly stored food waste
- Food residues in garbage cans and dumpsters produce many kinds of flies. Blow flies generally breed more abundantly in garbage cans than do house flies.
- Rodent and other animal carcasses in traps, on glue boards, in walls and other inaccessible places will produce many hundreds of flies if left long enough.
- Piles of warm, moist lawn clippings can be an important source of house flies in urban areas.
- Poorly cared-for compost piles or bins can produce many kinds of flies.
- Piles of manure can be a principle source of house flies in rural areas.
- Ripened, fermenting or rotten produce.
- Spilled juice, sugar water, food residue.

Management Strategies

To manage flies, it is most effective to concentrate on eliminating conditions that support the immature stages (maggots). This involves proper storage and disposal of food wastes as well as keeping waste receptacles clean. Many of these sanitation practices will prevent problems with other insects as well. The next most important management strategy for flies is denying their access to a structure.

Habitat Modification

To limit availability of food:

- Discuss the importance of sanitation with the appropriate people.
- Drain food wastes before placing in a plastic bag for disposal in a waste receptacle or dumpster.
- Use plastic liners in all waste receptacles that might collect food garbage; seal the plastic liners before placing in outside dumpsters or garbage cans.
- Remove garbage containing food wastes from the building before nightfall or tie a knot in the plastic liner.
- Store garbage in closed, rodent-proof dumpsters or garbage cans outside the building and away from doors.
- Keep waste receptacles and dumpsters clean; use a high-pressure stream of water or a brush and soapy water. Rinsing with a mild solution of borax or baking soda and water will eliminate odors.
- Flies can breed in soil soaked with water used to clean garbage cans and dumpsters. Check these areas regularly and scrape up any maggots along with the soil, and dispose of the material in a sealed plastic bag.
- Promptly fix drains or electric garbage disposal units that leak or drains that allow food waste to accumulate under sinks or floors. This food waste will attract many different kinds of flies.
- If drains or garbage disposal units do leak food waste, remove all the food waste and clean the area thoroughly.
- Store food in the refrigerator, freezer, or cooler, or in insect-proof containers such as Tupperware or screw-top jars (screw-top jars are not insect-proof unless the lid has a rubber gasket).
- Limit areas where food can be eaten and make sure to clean those areas after holiday, birthday, or other kinds of parties.
- Remove and clean pet dishes after pets have eaten.
- Outdoors, pick up and remove fallen fruit as soon as possible.
- Maintain compost piles properly, otherwise they can produce large numbers of flies.

Flies are strongly attracted to odors that come from materials that might provide them food or a place to lay eggs, and they can detect these odors over long distances. To limit attractive odors:

- Place dumpsters, garbage cans, and recycling containers away from outside doors to the building.
- Keep dumpsters and garbage cans clean to eliminate odors (see above)
- Empty dumpsters and garbage frequently, at least once a week; consider twice-weekly garbage pickup during warm weather if the fly problem is severe.
- Drain food garbage and store in sealed plastic bags. In schools, the smells of souring milk and yogurt in hundreds of containers thrown into dumpsters can attract thousands of flies from the surrounding neighborhood.
- Remove animal feces as soon as possible, place in a sealed plastic bag, and then into a waste receptacle or dumpster.

- The brown- to cream-colored fly specks found on walls and other surfaces where flies rest have a strong fly-attracting odor. They should be frequently cleaned off of surfaces with an odor eliminating cleaner (a mild solution of borax or baking soda and water is effective).

Physical Controls

Physical controls employ physical means to remove flies or prevent their entrance to a structure. To prevent fly entry:

- Tightly screen all windows and doors
- Weather-strip all windows and doors
- Seal gaps around windows and doors
- Screen air intake and exhaust vents
- Equip doors with self-closing devices to prevent their being left open inadvertently
- Install air curtains on doors that must remain open and cannot be screened. The air stream must have a velocity of 1,600 feet per second to be effective.
- Sticky fly tape and/or fly swatters can eliminate a small number of flies indoors; however, fly paper may be considered unsightly.
- Outside, cone-type fly traps with strong-smelling bait can be extremely effective in helping to control fly populations.
- Fly traps using ultra-violet light bulbs can be effective inside as a supplement to other measures. They must be used in areas where they are not competing with natural light. Follow the manufacturers' instructions carefully.
- Fruit fly traps with scented bait can be effective in controlling small populations.
- Note that *Fannia* (the little house fly) is not attracted to the same baits or traps as the house fly. A fan directed at circling *Fannia* will make the area less attractive to them because strong air currents disperse them.

Biological Controls

There are some effective biological controls available for controlling flies when the habitat is suitable. *Steinernema feltiae* is an effective control for Fruit Flies when released in perpetually moist environments where flies may be breeding. Other controls may be available and should be explored as fly species are identified**.**

Chemical Controls

Chemical controls are not recommended for fly control.

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Pigeons

Management Strategies

Pests need food, water and shelter to survive. Pests also need access to a structure and a way to move around within the structure in order to make them a nuisance inside a building. If even just one of these factors can be reduced (or eliminated), the environment will support lower pests and pests will be less likely to invade our living spaces.

Habitat Modification

To limit food and water availability

- Reduce number of temporary water sources such as puddles, leaks, or any open container of water.
- Properly discard garbage and food items in and around infested area in a container which inhibits access to birds.

To limit shelter/ harborage availability

- Structural modifications to reduce nesting, roosting, and loafing sites:
    - Change ledge angle to 45°
    - Install plastic netting
    - Use repellants such as plastic or metal spines, monofilament or steel lines, or gel or pastes.

Physical Controls

Physical controls employ physical means to remove pigeons or prevent their access to or movement within a structure.

- Exclusion is the best method for controlling the pigeon population in a city or non-rural area.
- Structural modifications to buildings to discourage pigeons, such as spines, netting, and gels, help to deter pigeons from nesting, roosting and loafing.
- Trapping and releasing pigeons elsewhere is not an option due to their homing abilities. Pigeons will usually return to the same place where they were trapped and continue to cause problems.

Chemical Controls

Chemical controls are used to directly suppress a pigeon population.

- Birth control for pigeons can be administered and over time the pigeon population can be significantly reduced.

Chemical frightening agents use grains coated with a material that elicits distress symptoms and calls when consumed and can repel the rest of the flock from the area.

Bed Bugs

Pestec has dealt with bed bugs throughout the San Francisco Bay Area. Pestec is uniquely posed to deal with a possible bed bug infestation. They use highly trained K9 bed bug detection units to determine the size and scope of an infestation, and through their work on bed bugs throughout the bay area and in supportive housing units, they have a well trained staff which are highly skilled at bed bug abatement.

Introduction to *Cimex lectularius* – the human Bed bug

Cimex lectularius, commonly referred to as the bed bug, has been a pest to human beings for ages. Throughout the ages the bed bug has had over 50 common names. Examples of other names include the wall-louse, house bug, mahogany flat, red coat, and crimson rambler. It has been many decades since they have been a real threat to our quality of life, but recently bed bugs are becoming a nationwide problem.

There are a couple of theories as to their return. One theory is that the change in the use of pesticides from broad spectrum and long lasting insecticides such as organophosphates to roach-specific baits has eliminated a potentially prophylactic control that killed newly introduced infestations. Secondly, bed bugs are more common in cities with abundant tourism. The theory is that bed bugs are possibly making their way over as “stowaways” in luggage from other countries as globalization has increased international travel. We do know that most strains of bed bugs are resistant to the chemicals available today for control, that bed bugs become resistant to the chemical DDT within a decade of its introduction and that further chemical resistance can be expected in the future.

Bed bugs have been found infesting hotels, apartments, movie theaters and private homes. It is common to find infestations in highly populated cities with an abundance of international visitors from Europe, South America, and Asia where the bed bugs are more likely to thrive. Although bed bugs survive on blood -- not filth -- it is much easier to eliminate bed bugs from an orderly room than a cluttered, unsanitary one. Bed bugs can even spread into the cleanest of hotels, restaurants, residential homes and apartments undetected. Bed bugs have been known to spread through second-hand furniture, bus seats and other used articles. Because the hitch-hiking bed bugs spread so easily, their ability to infest so rapidly is a concern.

Bed Bug Identification

- Adults are broad, oval and flat, approximately 4-5 mm long and 3 mm wide.
- They range in color from brown to reddish brown (after a blood meal).
- Prior to feeding bed bug nymphs appear translucent or pale in color. Nymphs resemble adults but are not dark like adults.
- Their bodies are covered with short, fine, golden-colored hairs that are almost invisible to the naked eye.
- They have a 4 segmented antenna with the third segment being longer than the second or fourth.

- The pronotum is deeply concaved to hold the head.
- Bed bugs give off a distinctive, disagreeable, sweet odor from scent glands.
- They usually deposit undigested parts of their blood meals in their hiding places which leaves a “rusty” residue.
- It is common to find these rusty spots on bed clothes and bedding where there is an infestation.

Bed bug identification

__	**Egg**	**Nymph**	**Adult**
Color	White	Clear with white color	Brown to mahogany
Distinctive characteristics	Oval shaped eggs	Wingless with flat body	Wingless with flat body
Length	1mm. or 1/32"	1-3mm. or 1/6"	3-4mm. or 3/16"
Reproduction and growth	Eggs hatch in 4-21 days depending on room temperature	Gradual metamorphosis. Nymphs molt 5 times during growth, requiring a blood meal before each molt	Adult females lay 1-5 eggs per day and will lay 200-500 eggs in their lifetime
Food		Feed on blood	Feed on blood. They prefer human blood, but have also been known to feed on birds bats and chickens
Habitat	Adults will not lay eggs on humans. Eggs can be found in cracks and crevices, bed frames, and carpeting. Eggs need the right temperature to hatch. Below 55.5°F and above 98.5°F eggs cannot hatch and will die.	Can be found living in the same areas of adult bed bugs	In any stage bed bugs are found in bedrooms, carpets, closets, inside walls, cracks and crevices.

Depending on the availability of food, 4-9 weeks is required from the egg stage to a healthy egg-laying adult. The average life span is 10 months. In a few surprising and interesting cases, bed bugs have been known to live over one year without food.

Why the Common Bed Bug is Considered a Pest

- Bed bugs primarily feed on humans but will also attack birds and other mammals.
- The bed bug bite is usually painless however many people are allergic to their bite and therefore react with itchy welts.
- Infestations can quickly multiply and spread throughout residential buildings.
- The common bed bug has been known to carry the causative agents for several diseases, such as anthrax, plague, tularemia, yellow fever, and typhus. However, no conclusive, scientific proof has been found linking bed bugs to these diseases.

Biology and Behavior of the Common Bed Bug

To be successful, management strategies must take into consideration the biology and behavior of the common bed bug. Understanding the biology of a pest can reveal weaknesses and vulnerabilities that can be exploited when trying to manage the pest.

General Biology and Behavior

- Bed bugs go through several developmental stages including egg, nymph, and adult stages. Nymphs will molt 5 times before reaching adulthood. Between each molt, bed bugs need at least one blood meal.
- Bed bugs feed on blood, mainly from humans but also rodents, birds and other animals.
- Females can lay 1-5 eggs per day deposited in cracks, crevices, or other dark, hidden places.
- Eggs are very small (1 mm) in length, oval and are white. The eggs are sticky and will remain in the same place they are laid.
- Eggs are found in cracks, bed frames, box springs, and carpeting.
- Eggs need the right temperature to hatch. Eggs will die below 55.5° F and above 98.5° F.
- It takes between 4-21 days for eggs to hatch, depending on temperature.
- At 70° to 90° F bed bugs can complete the egg to adult cycle in as little as 1 month.
- It takes about 3-10 minutes for bed bugs to get a whole blood meal.

- Adults and nymphs can be found in carpets, side walls, bedding, clothing, drawers, headboards, light fixtures, baseboards, pillows, backpacks and luggage.
- Bed bugs are nocturnal and usually feed while the person is sleeping.
- They prefer to hide where they feed, but will move to adjacent rooms if necessary.
- Bed bugs cannot fly but they can crawl quickly.
- The average lifespan is 10 months however with certain conditions bed bugs have been known to survive over a year without food.

Feeding Behavior

Bed bugs feed on the blood of humans and animals, having a preference for human blood. Their growth development is dependent upon this feeding. Bed bugs cause an allergic reaction in 80% of the cases. In extreme cases with many bites, nervousness, fatigue, sleeplessness, irritability, nervous and digestive disorders can occur. These symptoms are in addition to the itchy, uncomfortable white bumps caused by the bite. However 20% of people may show no physical symptoms to bed bug bites, and some develop immunity to the ectoparasites. Bed bugs can harbor disease organisms (i.e. relapsing fever, plague, Q fever), but have not been shown to spread viruses or disease.

Common Harborage

Because of their small size, bed bugs are capable of hiding in the smallest of places. Common locations where they are sighted include: mattresses, box springs, bed frames, headboards, light fixtures, baseboards, cracks and crevices, carpets, clothing, blankets, pillows, books, luggage, backpacks, light switches, smoke detectors, wall hangings, etc. Bed bugs are not limited to these places however.

In cases of severe infestation bed bugs have been found crawling on the occupant of the infested residence at which point there is a high-risk of bed bugs "hitch-hiking" to new areas in search of a host. In small infestations where a blood meal is not readily available bed bugs are more prone to hitch-hiking on items, persons, or by crawling away through wall voids, into hallways, etc. to find a more suitable living environment.

Factors that favor the common bed bug

- Poor sanitation makes inspection and treatment difficult but cleanliness has little to do with the presence of bed bugs.
- Clutter creates more harborage for bed bugs and makes inspection and treatment difficult.
- Cracks and crevices in wooden furniture and structural components like baseboards, as well as fabric lined furniture provides the preferred harborage for bed bugs.
- High people traffic areas creates more opportunities for bed bug introduction. Storage of personal belongings that are not regularly washed and exposed to many public and sleeping areas such as backpacks, luggage, and jackets.

Bed bug Assessment and Treatment

- Consultation with the room occupants- Bites? Insects?
- K9 bed bug inspection of infested space and adjoining rooms
- Inspection of the linens and mattress for insects, blood stains, bed bug fecal stains.
- Inspection of monitoring Devices: Sticky traps (i.e. double-sided tape, insect traps) should be kept along baseboards and furniture where the staff frequents and clothing storage.
- If bed bug activity is suspected in a room because of bite complaints, a more thorough inspection will be conducted
- Determine the extent of the infestation.
- Cost of replacement vs. treatment of items- is it less expensive to treat an infested item or replace it?
- Define treatment.

Post Inspection Treatment

Post inspection treatment will consist of steaming and vacuuming affected areas and continued monitoring of the area on regularly scheduled visits, to insure the problem does not persist. Bed bug problems in the California Academy should be limited in scope, however, if a wide spread infestation does occur, Pestec can take further steps to combat the problem including the use of bed bug heat treatments in affected areas.

Stinging Insects

Wasps and Yellowjackets

Control options may vary depending on the proximity to the public and perceived hazard. Optimally they will be carried out either at dawn or dusk. Caution tape may be installed around a nest to protect a passerby. The technician will be equipped with an appropriate bee suit.

- Ground nest - If necessary the yellow jackets will first be removed with a vacuum and/or treated with OhYEAH!. The nest will then be removed from the ground with a shovel. If necessary glue traps will be left behind to gather returning yellow jackets, and removed soon after.
- Structural void nest – The exiting yellow jackets will be removed with a vacuum and or treated with OhYEAH!. If possible the nest can be destroyed with a steam cleaner and as a last resort diatomaceous earth may be applied to the void. The point of entry/exit will have a glue board installed and removed soon after.
- Hanging nest – Will be scraped off and removed or bagged and removed depending on location.

Yellowjackets

Honey bees

Pestec will consult with a bee handler for the removal and relocation of bee's nests.

If there is suspicion that the bee's nest is of Africanized bees or if the nest presents an immediate hazard the bees will be removed by a vacuum, the nest will be destroyed by steam, the application of OhYEAH!, and as a last resort diatomaceous earth.

A recommendation will be made to remove the bees wax to prevent damage to the structure.

Arachnids

Black Widows

- Trapping – Sticky traps will be placed where they can be effective in catching black widows as they migrate into a sensitive area.
- Removal – Black widows will be removed by vacuum or destroyed with OhYEAH!

Spiders

- Removal – Spiders and their webs will be removed with a vacuum or Webber (web removing tool).
- Trapping - Sticky traps will be placed under furniture and in areas prone to crawling spiders.

As a last resort Diatomaceous earth may be applied onto damp surfaces that are prone to other insect activity and provide food for spiders.

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13. Structural and Operational Procedures that Facilitate Pest Management

Training

Shortly after new staff are hired they should receive training about their role in integrated pest management, particularly including review of the Academy Pest Prevention Policy. Food service, housekeeping, cleaning and maintenance staff should all have specific training regarding their roles in integrated pest management. This should include information on why minimizing hazards from pests and pesticide use is important, and how their job responsibilities specifically relate to integrated pest management and pest prevention.

Pest prevention training should be incorporated into the Human Resources Lifecycle orientation form which requires all training to be initialed by supervisors. This training should be on-going and updated as necessary.

Structural Changes

The building should be pest proofed as much as possible. This requires sealing cracks and crevices, voids, and openings into and within the building. When proofing is not possible other management options must be employed. These include:

- Access portals for inspecting voids
- Indoor monitoring/trapping stations
- Pest repellents
- Other IPM controls

The Academy building does have conditions where proofing is not immediately feasible but is being explored for correction in the future. These conditions are:

- Glass doors on the main floor, piazza, L3 balconies, and roof entrance that do not have weather/pest seals
- Wooden decking around the Planetarium and Rain Forest
- Un-screened windows
- Openings in the radiator covers by the Plaza windows
- Loading dock door

To mitigate the effect that these deficiencies have on the pest activity in the building we recommend:

- Installing skids to the bottoms of the trash receptacles to raise them slightly so that traps can be fit beneath the recessed back side for monitoring/trapping mice
- Creating portals in the desk walkways so that they may be inspected and monitored with traps
- Sealing interior doors to collections rooms (this has already been implemented) and monitoring with sticky traps
- Explore portals into the radiators for monitoring/trapping mice
- Give access to storage lockers in loading dock hallway to install monitoring/trapping stations for mice

General Sanitation and Maintenance

Areas in facilities that generally pose a problem as pest conducive areas are:

- Food preparation areas
- Break rooms
- Storage areas for food, research supplies, and office supplies
- Areas housing living and research collections
- Exhibit cases housing research and exhibit specimens
- Loading areas: specifically loading docks and their surrounding areas
- Waste management areas: trash compactors, dumpsters, etc.
- Cluttered areas throughout the building
- Drainage areas
- Faulty plumbing with leaky pipes
- Elevator shafts
- Crawl spaces

The elevator shafts should be cleaned on a regular maintenance schedule. Academy staff should coordinate with Pestec during regularly scheduled elevator maintenance to allow for inspections of the elevator areas that are not normally accessible during normal operations.

Entryways and Building Exterior

Entryways and the building exterior are the first lines of defense against invasive pests. Keeping these areas properly sealed can prevent pests from entering sensitive areas.

- Entryway mats should be long enough to allow four to five full steps before anyone enters the building. This will allow a sufficient amount of steps to remove dirt from the soles of shoes.
- All entryways should be equipped with door sweeps that close the gap between the bottom of the door and the door sill, astragal seals that close the space between double doors, and weather seals around the tops and sides of the doors.
- Each entryway should have a tight seal to prevent rodents and insects from entering the building. Door sweeps also save on energy costs and prevent windblown dirt from entering the building.

- Overhangs around the building exterior and light fixtures provide harborage for bird nests, and should be checked on a regular basis for bird activity. Possible deterrents include bird spikes and wire mesh around potential bird roost areas.
- Lighting around exterior areas should be placed at a distance away from the building to keep exterior light fixtures from attracting insects to areas near entryways.

Mechanical/Electrical/Plumbing

Interior pathways for electrical, mechanical, and plumbing can act as transit ways for pests. By making these areas inhospitable to pest life, pests can be prevented from traveling throughout the building.

- Sump pumps should be properly sealed to prevent potential fly breeding areas and to restrict access to cockroaches and other pests. Sump pumps are notorious for creating conditions conducive to pest activity.
- All electrical outlets should be sealed properly with foam gaskets, hinged covers, or caulking. This is true of gaps in any baseboards, around lighting fixtures, electrical panels, etc.
- All plumbing, piping and electrical access areas through walls should be properly sealed to prevent pest transit ways and harborage areas.

Storage Areas

Storage areas are ideal harborage areas for pests. Regularly monitoring these areas can prevent them from becoming a reservoir of pest activity.

- All cardboard boxes should be removed immediately after the products shipped with them have been properly stored. Cardboard boxes represent ideal pest harborage, particularly for cockroaches.

- All items should be stored above the floor on shelving units, to prevent pest access. There should also be sufficient space between stored items to allow regular inspections on storage spaces.

Storage spaces should be clean and orderly to facilitate inspection for pest activity.

Waste Management

Waste management areas are prone to pest activity. By insuring a high level of sanitation in these areas it is possible to prevent unwanted pest activity.

- Trash receptacles should be cleaned regularly to keep them from attracting pests.
- Trash receptacles with sealed tops are preferred to ones that remain open. (The trash receptacles viewed during the initial inspection were extremely efficient at keeping pests out.)

- Trash receptacles and compactors should be kept at a distance from the facility to prevent a potential pest harborage area from being located too close to main buildings.
- Trash receptacles should be emptied daily.
- Trash rooms should be cleaned daily to several times a day depending on usage and sanitation.
- The inside ledge of the compost bins doors should be cleaned daily and if possible the crevice it creates filled

Drains

Drains provide pests access to buildings from underground sewer areas.

- Fill all drains with clean water on a regular basis. Dry drains allow pests to access a building via the sewers below.
- Clean drains regularly to remove food debris, dead insects, and moisture retaining debris inside and outside of the building

Food Preparation Areas

Food preparation areas are a potential site for pest activity because of the abundant sources of food and water that can be found and exploited by pests.

- When mopping dirt and other food, ensure that debris is not pushed into corners and the base boards of hard-to-reach areas. Always make sure that most food residue is swept prior to mopping.
- Do NOT use hoses for floor clean-up. They add excessive water to the environment and push food into hard to reach areas.
- Keep food stored above floor level.
- Regularly wash drains with clean water, enzyme cleaners, stiff brush or steam.
- Remove cardboard boxes from food storage areas.
- Remove all food residues daily to keep from attracting pests.
- Dry all standing water after each shift daily.

Staff Break Rooms, Kitchens Offices and Cubicles

Staff break rooms pose a potential area for pest activity because too often food is improperly stored, personal plants harbor pests, or the area is not cleaned regularly.

- Empty trash receptacles daily.
- Clean dishes daily.
- Remove all food residues daily.
- Store food in pest resistant containers (i.e. glass or metal containers).
- Inspect personal plants regularly for pests. Remove pest infested plants or consult horticulturist for advice.

- Replace all upholstered furniture in areas where staff eat, to prevent food residue from becoming permanent.

Treatment of New Items Entering the Facility to Prevent Pest Introduction

Loaned collections, live plant material or items transported from off-site storage facilities may harbor pests that can impact living and research collections. Items should be treated and inspected to prevent introduction of new pests.

- Items that will tolerate freezing must be sent to off-site freezer and frozen at 0°F for 72 hours prior to introduction to the building. Small items may be frozen in on-site research freezer at 0°F for 72 hours.
- Items that will not tolerate freezing must be isolated (in a non red zone area) and inspected frequently over several days minimum for pests. If possible surface disinfect with alcohol.
- All living plant material introduced into the building must meet standards of Academy Plant Policy or receive visual inspection by horticulturist and recommended treatment.
- All live animals housed in the facility must be contained according to the requirements of the Association of Zoos and Aquariums.

14. Requirements for Non-Academy Occupants

It is the responsibility of Non-Academy Occupants to ensure practices in the areas under their control are consistent with the California Academy of Sciences IPM program. It is in the best interest of all occupants of the building to strive to minimize pest impacts and to keep mindful of the primary objectives of the plan as stated in the CAS Integrated Pest Management Plan Objectives. Toward this end Non-Academy Occupants should incorporate appropriate training, communication, cleaning and maintenance practices into their daily operations that will support these objectives.

Communication

Communication between pest management specialists and staff working in areas impacted by pests is a critical component to the success of any integrated pest management program. Early communication allows for early response to minimize damage and improve management of pests. Below is an outline of the communication pathway of pest sightings and deficiencies between Non-Academy Occupants, structural pest control practitioners and Academy representatives.

- Non-Academy Occupants with separate pest control contracts with Pestec must communicate pest sightings directly to Pestec.
- Non-Academy Occupants should train staff to be vigilant and report pest sightings promptly
- Pestec will communicate all deficiencies in non-academy occupant controlled areas to the appropriate Academy representative and the Pest Committee each month.
- Academy representative will follow up directly with managers of areas managed by non-Academy occupants to ensure they are resolved

Pest Prevention and Addressing Deficiencies

It is critical to the success of the Academy IPM Program that Non-Academy occupants take steps to prevent pest establishment in the Academy and to resolve all deficiencies identified by Pestec in a timely manner. Non–Academy Occupants must review the recommendations and specifications in the **CAS Integrated Pest Management Plan Description of any Structural or Operational Changes that would Facilitate the Pest Control Effort** and incorporate this information into daily practice in the areas under their control.

Practices that should be informed by IPM strategies include but are not limited to:

- General maintenance and housekeeping
- Exclusion and/or removal of habitat
- Cleaning and food storage
- Food handling and proper cleaning of food handling equipment and facilities
- Waste management
- Ensuring new materials introduced to the building are pest free
- Ensuring all staff and subcontractors abide by the Academy Pest Prevention Policy, and the California Academy of Sciences Pesticide Safety Program

Training of Staff

All staff should receive training as to what their role is in integrated pest management including review of the Academy Pest Prevention Policy. Food service, housekeeping, cleaning and maintenance staff should all have specific training as to what their role in integrated pest management should be. This should include information on why minimizing hazards from pests and pesticide use is important, and how their job responsibilities specifically relate to integrated pest management and pest prevention. This training should be on-going and updated as necessary. This training should include but is not limited to:

- Pest reporting
- Proper food storage
- Pest exclusion through maintenance and monitoring of doors and entryways
- Storage of personal items to prevent pests or pest habitat
- General housekeeping and cleaning
- Food handling and proper cleaning of food handling equipment and facilities
- Waste management

Regulatory and Reporting Requirements

It is the responsibility of Non-Academy Occupants to ensure their pest management practices are consistent with the ordinance all other local and state regulations. This includes and is not limited to:

- Ensuring other pest management strategies are exhausted and applying pesticides only as a last resort.
- Applying only pesticides listed on San Francisco Department of the Environment reduced risk pesticide list

Appendix A California Academy of Sciences Pesticide Safety Program

Policy

It is the policy of the California Academy of Sciences to control the use of all pesticides in its facilities, abide by all federal, state and local regulations regarding use of these chemicals and to minimize health and safety risks for personnel, visitors and the environment.

1.01 Integrated Pest Management

The Academy will incorporate the principles of Integrated Pest Management[1] in developing Pest Management strategies, using the least toxic pesticides only as a last resort to controlling pests.

1.02 Worker Protection Standard

The California Academy of Sciences will adopt the EPA Worker Protection Standard[2] for agricultural workers as its safety standard for all pesticide related activities.

1.03 San Francisco Integrated Pest Management Ordinance

As a property of the City and County of San Francisco, the Academy is subject to requirements of the San Francisco Integrated Pest Management Ordinance[3]. This includes public notification and pesticide use reporting and utilization of the "Reduced-Risk Pesticide List for City Properties".

Responsibilities

2.01 Pest Control Advisor, Kristen Natoli

Kristen Natoli, as the licensed Pest Control Advisor, is responsible for establishment and oversight of the CAS Pesticide Safety Program including record keeping, use reporting, training and observance of federal, state and local regulations. In addition, the Pest Control Advisor must develop written recommendations for all pesticides used at the Academy and report all pesticide usage to the Dept. of Agriculture and the Dept. of the Environment.

2.02 Supervisors of Qualified Applicators: are responsible for

a. Assuring that all pesticide applications are performed in a safe manner in strict adherence to federal, state and local regulations, including the EPA Worker Protection Standard, San Francisco Integrated Pest Management Program for City Properties and with observance of the recommendations of the CAS Pesticide Safety Program.
b. Assuring that all pesticide applications are performed by a Qualified Applicator or under the direct supervision of a Qualified Applicators Certificate holder.

c. Assuring all pesticide 'handlers' and 'workers' are trained according to the requirements of the Worker Protection Standard.
d. Assuring protection from retaliation for any worker or handler who attempts to comply with the EPA Worker Protection Standard.
e. Assuring that safe practices are followed in all activities involving pesticide use within their areas of supervision.
f. Assuring all required documentation and use reporting is maintained and current.

2.03 Pesticide Handlers: All persons performing pesticide applications are responsible for strict adherence to the provisions of the CAS Pesticide Safety Program, federal, state and local laws and requirements on individual pesticide labels. Specific requirements include:

a. Ensuring proper posting and/or verbal communication of pesticide application prior to applying any pesticides.
b. Ensuring required reporting of all pesticides used in monthly use report.
c. Use of all required personal protective equipment as required on pesticide label.
d. Notifying Hazardous Materials Monitor and Pest Control Advisor of unplanned exposure, accidents or spill.
e. Becoming knowledgeable of the information contained in the EPA Worker Protection Standard and the California Pesticide Safety Information Series[4].
f. Familiarity with Specimen Label and MSDS of individual pesticides prior to pesticide application.
g. Precise mixing, measuring, calculation of mixing rates and calibration of equipment.

2.04 Worker: All staff working in areas where pesticides are applied is responsible for strict adherence to the CAS Pesticide Safety Program and EPA Worker Protection Standard and the California Pesticide Safety Information Series. Specific requirements include:

a. Becoming knowledgeable of the information contained in the EPA Worker Protection Standard and California Pesticide Safety Information Series
b. Observing all pesticide application postings or verbal warnings and strictly observing all Restricted Entry Intervals
c. Becoming knowledgeable of the risks of exposure to pesticides and measures to be taken to reduce risk

2.05 Hazardous Materials Monitor requirements include:

a. Assistance to Pest Control Advisor as needed.
b. Providing storage, labeling materials and personal protective equipment to CAS applicators.
c. Assistance in spill clean-up.

Definitions

- Pest - definition taken from **California Food and Agriculture Code 12754.5**

  "**Pest**" means any of the following that is, or is liable to become, dangerous or detrimental to the agricultural or nonagricultural environment of the state:

  (a) Any insect, predatory animal, rodent, nematode or weed.

  (b) Any form of terrestrial, aquatic or aerial plant or animal, virus, fungus, bacteria, or other microorganism (except viruses, fungi, bacteria or other microorganisms on or living it man or other living animals).

  (c) Anything that the director, by regulation declares to be a pest.

- Pesticide – definition taken from **California Food and Agricultural Code 12753**

  "**Pesticide**" includes any of the following:

  (a) Any spray adjuvant

  (b) Any substance, or mixture of substances which is intended to be used for defoliating plants, regulating plant growth, or for preventing, destroying, repelling or mitigating any pest, as defined in Section 12754.5, which may infest or be detrimental to vegetation, man, animals or households, or be present in any agricultural or nonagricultural environment whatsoever.

- Integrated Pest Management – Definition from **San Francisco Integrated Pest Management Ordinance**[3]

  "**Integrated pest management**" means a decision-making process for managing pests that uses monitoring to determine pest injury levels and combines biological, cultural, physical, and chemical tools to minimize health, environmental and financial risks. The method uses extensive knowledge about pests, such as infestation thresholds, life histories, environmental requirements and natural enemies to complement and facilitate biological and other natural control of pests. The method uses the least toxic synthetic pesticides only as a last resort to controlling pests.

- EPA Worker Protection Standard (WPS) :
  The WPS is a federal regulation designed to protect agricultural workers, pesticide handlers and surrounding people and environment from the hazards associated with pesticides and pesticide application.
- Worker – from EPA WPS :
  "A worker is anyone who: (1) is employed (including self-employed) for any type of compensation and (2) is doing tasks, such as harvesting, weeding, or watering, relating to the production of agricultural plants on a farm, forest, nursery, or greenhouse."
- Handler – from EPA WPS Quick Reference Guide :
  "people mixing, loading or applying pesticides or doing other tasks involving direct contact with pesticides"
- Restricted Entry Interval (REI) :
  The interval between the time a pesticide is applied and when workers may enter the field.

Control criteria

In establishing controls for the use of Pesticides the following criteria shall be used:

Compliance with Federal, State and local regulations:
As a minimum all use shall be conducted to assure that Federal EPA standards, California Department of Pesticide Regulation laws and regulations and San Francisco county Department of Agriculture inspector requirements are met or exceeded at all times

San Francisco Integrated Pest Management Ordinance:
In addition all use will meet or exceed requirements stated in S.F. Integrated Pest Management Program for city properties including:

(a) Limiting use to pesticides listed in Reduced – Risk Pesticide List for City Properties
(b) Using the least toxic synthetic pesticides only as a last resort to controlling pests.

Procurement

Before a pesticide is received, label and MSDS must be reviewed and a written recommendation from Pest Control Advisor must be obtained. All new pesticides must be added to the inventory and reported the next scheduled inventory update.

Storage:
Pesticides must be stored in a designated chemical storage cabinet, labeled as such and placed in unbreakable secondary containers. Storage room must have Pesticide Storage sign on outer door.

Labeling:
all chemicals must be stored in their original containers or labeled with the information below. Pesticide sprayers containing pesticides or temporary storage containers for transport of pesticides must also be labeled at all times with the following:

- Name of pesticide
- Signal word
- Name and address of person responsible for the container and pesticide

Hazard communication

Record keeping, posting, reporting, and all other hazard communication must adhere to the requirements of the EPA Worker Protections Standard, CA Pesticide Safety Information Series and SF Integrated Pest Management Program for City Properties.

Per requirements of the SF Integrated Pest Management Program all pesticide applications excluding baits must be posted in a location visible to the public for 3 days

prior to application and 4 days following application on every entrance to building or surrounding perimeter of outdoor areas of application.

The following information must be located in a designated location known to all 'Workers" at the California Academy of Sciences:

- All pesticide applications for the last 30 days must be posted
- A binder containing specimen label, MSDS and written recommendation for each pesticide
- EPA worker protection poster, California Pesticide Information Series A-1 and A-8 and Emergency Information (name, telephone # and address of nearest facility) must be posted

Protective equipment assurance

- Supervisor must provide Pesticide Handlers with the Personal Protective Equipment (PPE) the pesticide label requires for the task and be sure it is clean and in operating condition, worn and used correctly and replaced or repaired as needed.
- Clean and secure storage will be provided for PPE
- Pesticide handlers must inspect PPE before each use

Pesticide application protocols: When applying pesticides handlers should consult the following checklist ensure following of safe and proper procedures:

Checklist for Pesticide Applications

Preparation:

- ❑ Have advisor recommend the appropriate pesticide for the application. Make sure there is a written recommendation on hand for that pesticide along with Specimen Label and MSDS.
- ❑ Post Public Notification notices 3 days prior to application and remove on the 4th day following application
- ❑ Thoroughly read and understand the recommendation, label and MSDS.
- ❑ Perform necessary calculations to determine amount of pesticide per gallon, determine how many gallons you think you will need to apply, always plan on mixing slightly less, better to have to remix than to be left with a lot left-over.
- ❑ Charge sprayer if battery operated
- ❑ On the day of the application, add the application to the pesticide application record, reprint and hang **before** applying pesticides.
- ❑ Write out 'No Entry' signs prior to application. Be sure to have a sign for every entrance! Include the following information:
    1. name of pesticide
    2. EPA#
    3. signal word
    4. date and time of application
    5. Reentry Interval.

- Gather all PPE required by the label, **be sure to wear a minimum of goggles, chemical resistant gloves and Tyvek suit for every pesticide application.**
- Gather spray equipment including sprayer and proper measuring equipment.
- Know where the closest emergency spill cart and emergency wash station are located, is there clear access?
- Label sprayer with the chemical name, person and business responsible (you and California Academy of Sciences) for the sprayer, signal word and EPA#. (This may seem unnecessary but is required. Dept. of Ag. Inspector will be looking for it.)
- Just before spraying hang signs on all entrances or around perimeter of area scheduled for spraying and move all equipment inside area to be sprayed.

Application:

- **First make absolutely sure all personnel have vacated the rooms to be sprayed**.
- Gather all equipment into a good spot for mixing, where water is accessible and there is a clean, flat, location with good lighting for measuring chemicals.
- Put on all PPE, tuck sleeves of suit into gloves, be sure to wear hood of tyvek suit. **DO NOT REMOVE GOGGLES TO SEE BETTER WHEN MEASURING CHEMICALS!!** If you cannot see with the goggles on, get a new pair.
- Test sprayer before mixing pesticides by filling with one gallon of tap water and spraying out. Adjust nozzle if needed, look for leaks.
- Fill the spray tank to half the desired volume.
- Carefully measure the pesticide chemical very accurately, holding measuring equipment **over** the open spray tank (in case of drips). Be sure to triple rinse measuring equipment into spray tank each time you mix.
- Add remaining water, watching carefully to ensure accuracy. Always be sure there is a gap of several inches between the water surface and the end of the hose when filling, to avoid siphoning pesticides back into the hose when you turn it off.
- Tighten lid of tank and if possible agitate tank gently to mix.
- Point spray nozzle away from plants and spray a small amount to test pressure and spray pattern.
- Spray plants thoroughly, coating underside of leaves as well, if possible. Spray just until plants begin to drip, you don't want a lot of runoff of wasted pesticide.
- Spray plants in a systematic order so you are sure not to miss any.

Clean-up:

- When finished spraying use up any left-over pesticide in tank by re-spraying plants that have begun to dry. **Never pour pesticides or rinse water from spray tanks down the drain.**
- Add approximately one gallon of water to spray tank and spray empty racks, walls, floors (only if you can be sure water will not go down any drains). Repeat this 2 more times.

- Gather all pesticide application materials, clean up application area, move all materials to the entrance.
- Remove Tyvek suit by unzipping and turning inside out. Stuff deep into the garbage where it is unlikely to be handled.
- Return chemicals, sprayer and mixing equipment to storage. Mixing equipment used for pesticide applications should be considered contaminated and should be stored in the pesticide cabinet. Make sure pesticide cabinet is locked.
- Charge sprayer if battery operated
- Wash goggles and gloves **inside and out** with warm soapy water, hang to dry.
- Wash arms, hands, face and neck twice with warm soapy water.
- Record all required information including total # gallons applied and chemical used in the pesticide application spreadsheet. You've finished!! Don't forget to remove signs from doors immediately following the REI expiration!!

References

1. Integrated Pest Management
http://www.sfenvironment.org/downloads/library/ipmordinance.pdf

2. EPA Worker Protection Standard –
http://www.epa.gov/oecaagct/epa-735-b-05-002.pdf

3. San Francisco Integrated Pest Management Ordinance
http://www.sfenvironment.org/downloads/library/ipmordinance.pdf

4. California Pesticide Safety Information Series
http://www.cdpr.ca.gov/docs/whs/psisenglish.htm

5. Restricted Entry Intervals
http://www.epa.gov/oecaagct/epa-735-b-05-002.pdf

Appendix B California Academy of Sciences Pest Prevention Policy

The California Academy of Sciences houses a large variety of living and scientific collections and equipment, much of which is susceptible to damage caused by insects and rodents. Many collections rooms are adjacent to offices, kitchens and break room areas and are at risk of damage due to destructive pests associated with food and trash. Pests also pose potential health risks to humans. To preserve the Academy's important and irreplaceable collections and to protect the health of staff and visitors, the following policy has been adopted.

Food

- Keep all food products, as well as gum, mints, vitamins and tobacco, in sealed containers or in the refrigerator or freezer. Non-refrigerated food stored for longer than a day should be kept in sealed glass, metal or ceramic containers, as rodents can chew through plastics. Food may also be stored overnight in sealed plastic containers, provided those containers stay within rodent-proof staff kitchen cabinets. Screw-top jars are not insect-proof unless the lid has a rubber gasket.
- Keep food storage and kitchen areas clean. Clean all work surfaces and dishes immediately after preparing or consuming food. Do not leave dirty dishes in sink.
- Dispose of food and food wrappers/containers in appropriate recycling, compost or landfill receptacles. Rinse food containers before depositing in appropriate bins.

Housekeeping

- Keep kitchen and lunchroom doors closed.
- Keep lids closed on recycling, compost and landfill receptacles, and ensure the receptacles are emptied regularly.
- Only open windows with screens and keep screens closed.
- Keep work spaces clean.

Building Perimeter

- All exterior, non-public doors must be kept shut at all times.
- Custodial staff are required to monitor trash and loading dock areas to reduce the risk of infestation.
- In the event of an infestation, all deliveries may be subject to inspection.

Plants

- Plants and flowers, especially garden cuttings, can harbor destructive insects. Personal plants and flowers should thus be kept to a minimum and monitored regularly to prevent infestation.
- Bear in mind that some pests are microscopic, thus the appearance that an item is pest-free does not necessarily mean that it is.

Monitoring

- Any pest sightings should be reported to Operations via the Pest Report Form on the intranet (http://intranet.calacademy.org/forms/operations/pest_report/). Please include as much information as possible.
- If it is possible to do so safely, trap any pests sighted and give to a member of the Pest Committee for identification.

- Members of the Academy's Pest Committee will regularly inspect the building to ensure staff are doing everything possible to protect our collections. Food left uncovered or improperly stored will be noted, and in some cases, removed.

Zones

- The back-of-house portion of the building has been divided into zones outlining in which areas food and drink are permitted to be consumed and/or stored. The zones are as follows:
    - Red: No food or drink allowed at any time
        - Red zones are areas highly susceptible to infestation, such as Aquarium holding rooms, the CCG and SEM labs, collections rooms, the Library Reading Room, parts of the Naturalist Center, etc.
    - Orange: Food consumption permitted, but no overnight food storage
        - Orange zones are spaces that could easily attract pests if food or food containers are consistently present, including offices and cubicles, conference rooms, and the classroom.
    - Yellow: Food storage allowed in sealed containers or in the refrigerator or freezer
        - Yellow zones are the only back-of-house areas in which food storage is permitted. Yellow zones consist of kitchens.

Revised by CAS Pest Committee May 2010

California Academy of Sciences Inspection Data Map and Structural Map

Policy for Non-Exhibit Plants and Floral Displays

Plants and Floral Displays for Events:

- No rental plants or floral displays for events will be permitted in Rainforest Bolla.
- Whenever possible plant rentals and floral displays should be staged in contained exhibit areas such as piazza, auditoriums and Africa Hall
- Plant rentals should be from reputable interior plant display companies and must be pest and disease free. **Decorative Plant Company** would be strongly preferred as vendor
- Scattering of flower petals and rice is not permitted
- Plants collected from any outdoor or natural areas are not permitted unless inspected and approved by horticulture staff.

Visitors:

- No visitor is permitted to carry outside plants or cut flowers through the Academy museum. Visitors carrying such items at entry may be permitted to leave them at security or ticket booth and reclaim them on their way out.
- Museum floral displays from professional floral designers are permitted at guest entrance, business entrance and conference rooms used for receiving visitors and should be regularly inspected by horticultural staff.

Staff personal plants and cut flowers:

- All personal plants and cut flowers must be pest and disease free. If plants are suspected of pest infestation staff may request inspection by horticultural staff (Kristen Natoli – Horticulturist or Alan Good – Outdoor Exhibit Supervisor).
- Staff should be aware of potential to contaminate research and collection materials with pests from introduced plants and flowers and should be vigilant and conscientious regarding plant materials in their own areas.
- Cut flowers or plants collected from any outdoor or natural areas for purposes other than research are not permitted.

Revised by Kristen Natoli Oct 2010

Appendix C Pestec Customer Access Portal

Customeraccess.pestec.net is Pestec's customer portal to Pestec's services. The site streamlines the relationship between Pestec and its customers by giving Pestec customers an online location to view information about Pestec services.

Pestec provides structural integrated pest management (IPM) for the City and County of San Francisco. Each of Pestec's accounts has a Pestec customer access login. IPM coordinators from City and County departments have administrative rights over the accounts that Pestec services. IPM coordinators act as administrators for each of their department's locations and the pest management services Pestec provides.

The information below provides an overview of Pestec's customer access website.

California Academy of Sciences structural IPM program customer access

Two types of customers have access to customeraccess.pestec.net from the California Academy of Sciences: IPM coordinators who are responsible for ordering services and act as the primary point of contact for Pestec, and employees who are stake holders in pest management.

Pestec customer access IPM coordinators

IPM coordinators will be given customeraccess.pestec.net administrator rights for all of the accounts at the California Academy. Each location that Pestec services has an associated user; however, many of the locations Pestec services are coordinated through a central location, or administrator. The separate locations under the authority of a central administrator each have customeraccess.pestec.net user accounts maintained by the account administrator through customeraccess.pestec.net. The information below explains the layout and uses of customeraccess.pestec.net for IPM coordinators.

Login

To login to Pestec's customer access site visit http://www.pestec.com/login or http://customeraccess.pestec.net. Once there you will be prompted to give three pieces of information.

- Account
- Username
- Password

These three pieces of information have been provided to each location's IPM coordinator by Pestec. IPM coordinator usernames are always [admn]. The admn login will allow IPM coordinators to maintain all of the coordinator's user accounts and service locations. Each location has its own username and password. Information on maintaining user accounts is listed below under the subsection *Maintain users*. Once you are logged in you will be taken to your *My Account* page where you will find the following services.

Account statement

The Account Statement is a list of all invoices with an unpaid balance. You can view your statement online or print it out for remittance with your payment.

Service History

The service history report shows a list of each service visit sorted in date order.

Open Service Orders

The open service orders report shows a list of each open service order by location in date order.

Payment History

The payment history report shows a list of each payment including the date, amount and the invoice that was paid.

Billing History

The billing history report shows a list of each invoice billed to your account sorted in date order.

Material Usage History

The material usage history report shows the date, type of material, and building address for each material application in your account. Material labels and material data safety sheets will be available in the *My Documents* section of Pestec customer access.

Device history

The Device History gives you a view of one or all devices with an indication of the activity level and current status.

My documents

The *My documents* section is where you will find copies of any pictures and technical reports that we might have on file for your account. Integrated pest management plans for your location, building diagrams, material labels and material data safety sheets, and letters of recommendation will also be kept in the documents section. Another list of helpful documents, including pest fact sheets and information about the San Francisco structural integrated pest management program are accessible on the web. A list of these helpful urls will also appear under the *My documents* section.

Deficiencies

The deficiencies section will list all of the structural deficiencies conducive to pest activity discovered during regular service at your locations. These include poor sanitation conditions, areas requiring structural repair, habitat modifications to limit pest activity, and recommendations from Pestec technicians for building staff.

Pay for service

Now you can pay for your service right online. Just click here and answer a few simple questions to pay your bill.

Ask a question

If you have a question about a pest or about your service just type it in here and one of our customer service representatives will get your question answered promptly.

Update Account Info

If any of your information is out of date, you can let us know here and we will update our records as soon as possible.

Maintain Users

You can control access rights to your online account for each user and location where you coordinate pest control. When you enter the **maintain users** section, you will be shown a list of all of the users and locations administered by your account. Here you can change user names and passwords for each of your locations, and change what information users can see about their accounts. Default non-admn user accounts have limited access to account activity, but are allowed to see service history, device and

material usage, documents and structural deficiencies. Account administrators will also be allowed to add new users to different locations from this page if necessary.

Change password

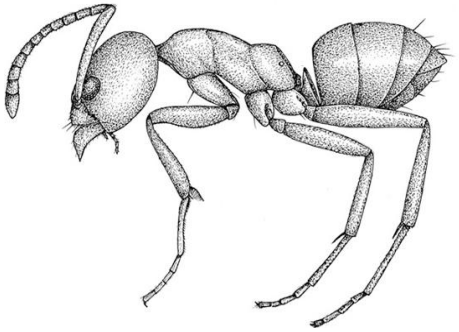
For security purposes, we strongly recommend that you keep your password private. If you need to change it for any reason you can click here.

Logout

The logout button in the navigation bar will log you out of Pestec customer access. For security purposes you should always log out after you are done with your Pestec customer access session.

Appendix D Pest Fact Sheets

Pestec Fact Sheet: *Ants*



General Facts:

- Argentine ants are the most common species of ant that invades buildings.
- Ants have four life stages: egg, larva, pupa (cocoon), and adult.
- Worker ants are all the same size, around 1/8 inch long, uniformly dull brown in color.
- Argentine ants do not sting. Occasionally they may bite, but the bite is a mild pinch.
- Colonies are linked by tunnels with workers and queens moving freely from nest to nest.
- It may be more accurate to think of Argentine ants as living in huge colonies with thousands of entrances.

Ant Behavior:

- Adult worker ants (all females) feed and care for the young, but also feed each other and the queens.
- Adult ants feed only on liquids, but they collect solid food for larvae (the immature stage) living in the nest. Larvae digest the solid food and produce liquids for the workers to feed on.
- On average at any one time, a very small proportion of a colony is out foraging for food, so killing these ants will not eliminate the colony.
- Argentine ants will forage 200 ft. away from their nest.
- Argentine ants feed on just about anything from dead animals (including insects) to all kinds of human and pet food.
- A favorite food is the honeydew produced by insects such as aphids, mealybugs, scales, and whiteflies. Argentine ants protect these insects from their natural enemies.
- Argentine ants move their colonies within hours to take advantage of a food source or to escape inhospitable conditions. In winter they look for places that are warmer and drier, and in summer they seek cooler and moister sites.

Outside, ants nest:

- Near irrigated turf and other landscaping.
- In planters and potted plants.
- In the ground under trees, especially trees with honeydew producing insects, near faucets and irrigation valves under sidewalks, stones and patios.
- In soil accumulated in the corners of a roof

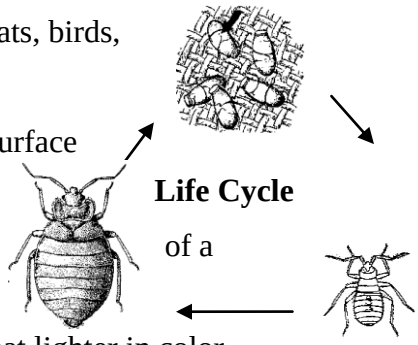
Inside, ants nest:

- In potted plants
- Inside cupboards and drawers
- Under tiles on kitchen counters, behind wall tile and brick veneer
- In the insulation in dishwashers, washing machines, and refrigerators, in wall voids, in moist basements, and in vehicles
- In unusual places such as inside metal curtain rods

Pestec Fact Sheet: *Bed Bugs*

General Facts:

- Bed bugs feed on blood, mostly from people, but also from bats, birds, and rodents.
- Bed bugs go through several stages in their lives:
    - Tiny eggs (the size of two grains of salt) stick to the surface on which they are laid.
    - Eggs hatch into "nymphs" which at first are the size of a pinhead.
    - Nymphs resemble adults, but are smaller and somewhat lighter in color.
    - Nymphs grow and shed their skin (molt) 5 times before becoming adults.
- Bed bugs will live in both clean and dirty environments; however a messy room provides more hidings spaces and makes inspection and treatment more difficult.



Life Cycle

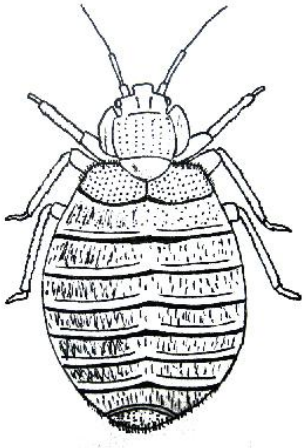
Bed bug behavior:

- They feed at night.
- During the day they hide in cracks, crevices, or other protected locations.
- They prefer to hide near where they feed, but can be scattered throughout a room and can move to adjacent rooms.
- They cannot fly but they can crawl quickly.
- Bed bugs can travel considerable distances in a night to feed (up to 150 ft.)

actual size

Bed Bug Bites:

- Bed bugs usually bite people at night while they sleep.
- Most people don't know they are being bitten.
- Reactions to bites vary greatly from itchy red welts to little or no irritation.
- Bites will be concentrated on areas exposed while sleeping (face, neck, arms, hands, etc.)



What You Can Do to Prevent Bed Bugs:

- Eliminate hiding places
- Eliminate clutter
- Remove bed skirts and other upholstery fabric that hangs from the bottom of furniture and touches the ground.
- Inspect second hand furniture closely for signs of bed bugs, such as black spots.
- Wash bedding weekly (which also reduces dust and allergens)
- Store items in plastic containers, especially items located under the bed.

Pestec Fact Sheet: *Cockroaches*

General Facts:

- Cockroaches avoid light and will feed on almost anything including decaying organic matter, garbage, and other cockroaches.
- Cockroaches have 3 distinct life stages: egg, nymph, and adult. Immature cockroaches resemble adults.
- The three most common species of cockroaches which invade buildings are the American cockroach, the Oriental cockroach, and the German cockroach.
- American cockroach adults are a shiny reddish to dark brown, but seldom darker than a reddish chestnut and about 1 ½ inches long.
- Adults have wings and will occasionally fly, although they prefer to run.
- Oriental cockroach adults are dark brown to black, usually with a greasy sheen to their bodies.
- The females are about 1¼ inches long with rudimentary wing pads while males are about 1 inch long with wings that cover only about ¾ of the body.
- Oriental cockroaches are incapable of flight.
- German cockroach adults are pale to medium brown and about ½ to 5/8 inch long with 2 dark stripes running parallel to the body on the upper surface of the first segment of the thorax.

American Cockroach

Oriental Cockroach

German Cockroach

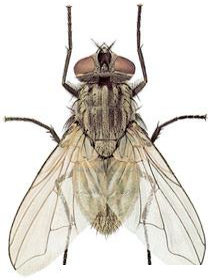
Factors that favor Cockroaches:

- Poor sanitation provides large quantities of food for cockroaches and makes them less likely to feed on poison baits, and thus harder to control.
- Grease and food waste in drains provide abundant food.
- Leaks and other sources of moisture provide water and increase the humidity of the environment.
- Clutter provides numerous hiding places.
- Poor building maintenance can provide cockroaches with access to structures and with harborage, water, and easy pathways from room to room within the structure.
- Little or no inspection of goods coming into the structure can allow cockroaches to hitch hike into the building.

Pestec Fact Sheet: *Flies*

General Facts:

- There are several species of flies including house flies, blow flies and drain flies.
- All flies have only 2 wings.
- Flies are associated with many disease-causing organisms and their habits make them efficient mechanical vectors of these organisms.
- All flies have 4 distinct life stages: egg, larva (commonly called maggot), pupa, and adult.
- The maggots of flies are legless, round in cross-section, tapered at the front end and blunt at the hind end, cream to yellowish in color.
- Flies feed on garbage, feces and manure, open wounds, and nectar.



House Fly

Blow Fly

Drain Fly

Fly Behavior:

- Adult house flies have sponging mouthparts that only allow them to eat liquids. Some solid foods can be liquefied with regurgitated saliva and then sponged up through the mouthparts.
- While feeding, flies also defecate on their food.
- Larvae feed on bacteria, fungi, algae, and other microorganisms associated with decaying organic matter.
- Wherever house flies rest, they leave "fly specks", light brown/cream-colors specks of saliva and excrement that are a strong attractant for other house flies.
- For resting places during the day or night, house flies prefer corners, edges, and thin objects such as wires and strings, but can be found surfaces such as walls, ceilings, floors, the ground, plants, garbage cans, and fences.

Factors that favor Flies:

- Improperly stored food waste
    - Food residues in garbage cans and dumpsters produce many kinds of flies. Blow flies generally breed more abundantly in garbage cans than do house flies.
- Rodent and other animal carcasses in traps, on glue boards, in walls and other inaccessible places will produce many hundreds of flies if left long enough.
- Piles of warm, moist lawn clippings can be an important source of house flies in urban areas.
- Poorly cared-for compost piles or bins can produce many kinds of flies.
- Piles of manure can be a principle source of house flies in rural areas.

Pestec Fact Sheet: *Mice*

General Facts:

- The house mouse has a small, slender body reaching between 5 and 8 inches in length and weighing about a ½ ounce.
- They have a buff or light brown upper body that fades into a grey underside.
- Mice can cause severe damage to structures from gnawing. They can cause fires, explosions, indoor flooding and damage to computer systems as a result of their gnawing on utility pipes and electrical wiring.
- Mice can carry a number of diseases. Hantavirus, a potentially lethal disease, is primarily carried and transmitted by the white-footed deer mouse.
- The average litter size for the House mouse is between 6 and 7 with up to 10 litters per year (depending on food availability). If conditions are right one female mouse can give birth to a litter every 24 to 28 days.

Mice Behavior:

- They are constantly exploring new things near the nest and actively forage for food in a 10 ft. radius from the nest.
- In and around buildings they will consume almost any readily available food but prefer cereals and grains.
- Indoors, mice may have period of active foraging during the day but will primarily forage about 30-60 minutes after human activity has ceased.

House Mouse

- Like rats, mice will typically not cross open spaces with little or no cover and prefer to travel instead along walls and corridors with some cover.

Factors that favor the House Mouse:

- Poor sanitation provides rats with ample quantities of food to sustain large numbers of mice.
- Improperly stored food and waste allows another food resource for mice populations to flourish on.
- Clutter and improper storage practices provides abundant hiding places, nesting sites, and travel routes for mice.
- Dense vegetation and ground cover can act as excellent nests and rodent highways.

Pestec Fact Sheet: *Rats*

General Biology:

Rats have multiple breeding cycles and will breed every 4-5 days. The gestation period last approximately 20-25 days with an average litter size between 5 and 12. Adult rats will generally live around one year. Rats have the potential to carry several harmful diseases including plague and typhus. Rats also carry tropical rat mites which can lead to mite infestations inside the building.

General Behavior:

Norway rats prefer foods high in carbohydrates or protein and will actively forage for food between dusk and dawn. Rats are mainly nocturnal, but can be seen during the day if colonies are overpopulated. They prefer to travel along edges, along pipes or rafters, or along the outside or inside of a foundation. Rats are generally wary of crossing open spaces that provide no cover. Hedges and other dense vegetation in landscaping or against buildings provide cover for rodent trails. Rats are also usually wary of new objects in their environment; however this is only a temporary hesitation. In some cases rats will enter buildings through sewer pipes. Broken manhole covers, broken laterals, or other breaks in the system allow access for rats.

Factors that favor the Roof and Norway rat:

Poor sanitation provides rats with ample quantities of food to sustain large numbers of rats.
Improperly stored food and waste allows another food resource for rat populations to flourish on. Pet foods are a common meal for rats and should be stored properly as well.
Clutter and improper storage practices provides abundant hiding places, nesting sites, and travel routes for rats.
Dense vegetation and ground cover can act as excellent nests and rat highways.

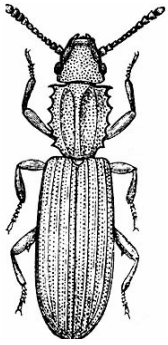
Management Strategies:

Proper sanitation along with exclusion is the most efficient management method for rats. Reducing or removing clutter will deter rats from finding suitable nesting sites. Rats use junk piles as refuge and harborage, protecting them from people, dogs, cats and other predators. Thoroughly cleaning previous nesting sites is important to eliminate the potentially dangerous health hazards posed from rodent feces and urine. Exclusion can include structural modifications, such as patching holes (1/2" or larger) with heavy wire mesh or installing door sweeps. Other control options include landscape modifications such as trimming tree branches away from roofs, eliminating vegetative cover for rat runways and removing trees which may serve as an abundant food source. To control for sewer rats, rodenticides are placed in manholes to help control rat populations in a specific area. Broken pipes where rats may be entering should be inspected and fixed as well.

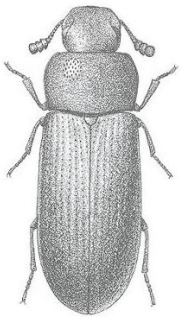
Pestec Fact Sheet: *Stored Product Pests*

General Facts:

- Stored product pests consist of beetles, moths, ants and other pests which infest stored foods such as flour, grain, cereal and dried fruit.
- Common species that infest stored products are saw-toothed and merchant grain beetles, drugstore beetle, cigarette beetle, Indian meal moth, confused flour beetle and the red flour beetle.
- No diseases are associated with these pests. However, they contaminate large quantities of the food they infest which makes it inedible as well as unmarketable.
- Indian meal moths are the most common food-infesting moth found in homes, grocery stores, and any place with dried or stored food.



Saw-toothed Grain Beetle



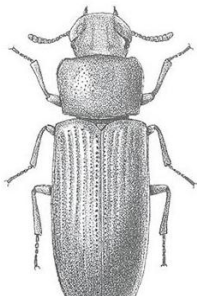
Red Flour Beetle

Stored Product Pest Behavior:

- Beetles go through four distinct life stages: egg, larva, pupa and adult.
- Indian meal moth adults are attracted to light and will often be mistaken for clothes moths when flying.
- The confused and red flour beetles give off a displeasing odor and their presence encourages the growth of mold.
- Flour and grain beetles are capable of chewing through paper, cardboard boxes, cellophane, plastic, foil, and many other types of packaging.

Factors that Favor Stored Product Pests:

- Improper storage of food products
- Failure to inspect food products and their packaging before storing.
- Storing food items for lengthy periods of time.
- Poor sanitation in food storage areas.
- Poor ventilation in food storage areas.



Confused Flour Beetle