National Park Service
U.S. Department of the Interior
Harpers Ferry Center
Conservation

MUSEUM COLLECTION INTEGRATED PEST MANAGEMENT PLAN

Klondike Gold Rush National Historical Park- Seattle Unit

EXPERIENCE YOUR AMERICA

Klondike Gold Rush National Historical Park- Seattle Unit

Museum Collection Integrated Pest Management Plan

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Museum Collection Integrated Pest Management Plan

Klondike Gold Rush National Historical Park- Seattle Unit
Seattle, Washington

PREPARED BY: _____
HFC CONSERVATOR DATE

APPROVED: _____
SUPERINTENDENT DATE

CONCURRED: _____
CURATOR OF RECORD DATE

CONCURRED: _____
KLSE IPM COORDINATOR DATE

CONCURRED: _____
FACILITY MANAGER DATE

CONCURRED: _____
REGIONAL IPM COORDINATOR DATE

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EXECUTIVE SUMMARY

This Museum Collection Integrated Pest Management (IPM) Plan for Klondike Gold Rush National Historical Park-Seattle Unit (KLSE) provides basic pest management guidelines to help preserve the Park's museum collections, the historic building they are housed in, and protect the health and safety of KLSE staff and visitors. Preventive methods such as exclusion, sanitation, and habitat modification are described, as well as direct actions such as trapping and freezer treatment of objects for pest control. Inspections and monitoring of pest populations and environmental conditions will determine the extent of pest presence and direct pest management actions.

This Museum Collection IPM Plan is based on a survey of museum collections and the historic Cadillac Hotel located at Klondike Gold Rush National Historical Park- Seattle Unit. The park's IPM program will help accomplish the goal of protecting the museum, archival, and library collections from damage from pests so they will be preserved for future generations. In preparation for the plan, a site visit was conducted by Barbara Cumberland, Assistant Conservator at Harpers Ferry Center on June 15-18, 2009. An emphasis of the Museum Collection IPM Plan was updating the program for the park to monitor for pests that might endanger the museum collections on exhibit and in storage. Historic objects related to the role that Seattle played in the Klondike Gold Rush and to the Klondike stampede (c. 1897-1898) are on exhibit in the Visitor Center; and the collection also consists of historical books, photographs, documents, and other archival materials related to the role played by Seattle as a point of departure and return and as a supply station for the stampeders, and the effect of the gold rush on Seattle's economy and population. The National Park Service (NPS) Pacific West Regional Library on the third floor of the Cadillac Hotel is also a targeted area of this museum IPM plan.

IPM at KLSE should be accomplished with a holistic team approach, with staff members from curatorial, maintenance, interpretation, management, and cultural resources having integral roles in the program. Maintenance activities in particular, including those supplied through the non-NPS facility manager, are essential in an IPM program.

A detailed pest monitoring program of trapping and recording pest catches into a computerized database was set up during the site visit and is being carried out. Pest monitoring is a continuous process, and will make the staff aware of pests that they would not notice otherwise. This ongoing monitoring will provide the data for making informed decisions about managing potential pest infestations in the KLSE museum collections located in the historic Cadillac Hotel.

The park curatorial staff has been conducting pest and environmental monitoring in the collection storage room for several years, and following a housekeeping schedule to keep the collections areas clean, and serious pest issues seem minimal. The following is a list of short-term and long-term recommendations for the protection of the museum collections at Klondike Gold Rush National Historical Park- Seattle Unit. The list is a brief summary compiled after discussion with park staff, site inspection, and pest monitoring.

Short-term Recommendations

- Implement the updated pest monitoring program by placing all the recommended traps around the building. Information from monitoring will determine if, when, and where management is needed.
- Continue and improve on current routine housekeeping procedures by thoroughly vacuum cleaning with a HEPA filter vacuum cleaner (especially vacuuming dead insects and spider webs), and reducing clutter. Clearly communicate the goals and techniques of the museum IPM program to the contracted janitorial staff through the facility manager (i.e.: not removing the

sticky traps, and thoroughly vacuuming floors all the way to and including the baseboards). [There has been some lack of communication between the park staff with curatorial duties and the contracted janitorial staff regarding the shared vacuuming duties in the exhibits because some essential vacuuming to eliminate pests has been neglected.]

- Remove insects and pest debris from objects in storage and on exhibit where necessary.
- Follow recommended procedures for dealing with current presence of the museum pests- clothes moths, silverfish, dermestids, and booklice.
- Enforce a written policy against food, drink, live plants, and flowers in all spaces where museum collections are housed, displayed, and researched. Reinforce these policies with posted signs where appropriate. Live plant material should not be allowed because it provides water, food, and shelter for insects. Many species of adult dermestid beetles do not feed on anything but the pollen of flowers, and they fly to flowers to mate. However, the larvae of dermestid beetles are serious museum pests that eat protein-based materials including wool, silk, feathers, leather, insect collections, taxidermy, and fur.
- Purchase at least one insect light trap and pheromone lures for varied carpet beetles and webbing clothes moths and use as recommended in this plan.
- Use the chest freezer (at MORA) as part of a pest control strategy to kill insect infestations on museum objects.
- Remove materials stored in the areaway. Establish a policy not to use areaway as storage space.
- Finish the single-layer walls between the areaway and the collection room and the exhibit room with insulation, a vapor barrier and additional exterior-grade wallboard on the areaway side, and caulk it well. A low-risk pesticide dust can be blown into the void between the walls.
- All of the rounded stones that are around the stairs on the lower level have been accumulating soils, spider webs, and large “dust bunnies” that dermestid larvae can survive on. These soils need to be thoroughly vacuumed to reduce food and harborage for spiders and these museum pests that can survive on lint. This should be done at least annually. This will involve temporarily moving sections of stones aside and vacuuming the stones and the spaces under and between them with a HEPA vacuum with a round brush attachment. The acting superintendent suggested that this might be a good volunteer project for the Boy Scouts.
- Notify all occupants of the Cadillac Hotel building and the contracted janitorial staff that any pest observations should be reported to the park IPM Coordinator.

Long-term Recommendations

- Continue the pest monitoring program and keep records of all monitoring, inspection, pest incidents, and control activities in an annual *Museum IPM Notebook* provided as part of this project.
- After gathering at least a year of monitoring data, action plans for individual pests can be added to Appendix A based on their locations and biology, if needed.
- Move the collection storage room to a location away from exterior walls and the areaway, like the Prospector Room. The curator has been giving this option serious consideration.
- When needed, implement structural repairs and policies to exclude pests from buildings wherever possible.
- Install 1/4-inch galvanized hardware cloth (19 or heavier gauge) on the underside of the sidewalk grate above the areaway to exclude rodents and prevent garbage from being thrown down through the grate.
- In offices where windows are opened for ventilation, install window screens (permanently, or purchase the adjustable type that can be placed in windows just when they are opened).

- Keep the relative humidity below 65% to prevent mold outbreaks.

INTRODUCTION

This Museum Collection Integrated Pest Management (IPM) Plan was prepared to assist Klondike Gold Rush National Historical Park- Seattle Unit's (KLSE) curatorial staff provide protection from museum pests that threaten to damage the park's museum collections. At KLSE, the exhibit and museum storage spaces targeted in the Scope of Work for this project are in the historic Cadillac Hotel in the Pioneer Square district of downtown Seattle. As part of the curatorial staff's duty to care for the park's museum collection, pest management is an important and ongoing challenge at KLSE.

Harpers Ferry Center- Conservation was asked to prepare an IPM plan for KLSE that includes a museum-oriented pest management inspection of the site and setting up an IPM program including monitoring of all spaces that house museum and library collections. PMIS funding through the Museum Collections Preservation and Protection Program (MCPP) was given for this IPM plan in response to overcoming a deficiency noted in the NPS Checklist for Preservation and Protection of Museum Collections. The checklist is a tool used in a park's self-assessment that is done to update progress on how well it is preserving and protecting the museum collections in its custody.

Assistant Conservator Barbara Cumberland of Harpers Ferry Center visited the park June 15-18, 2009 to conduct a pest management inspection and update the pest monitoring program at the buildings at the park that house the museum collections. Each room was examined carefully for pest evidence, areas of potential pest access, and susceptible objects to determine the extent and nature of museum pest problems at Klondike Gold Rush National Historical Park- Seattle Unit. The museum curator at KLSE was asked to place sticky pest traps in all of the rooms that hold collections a month before the site visit to give the surveyor a baseline indication of pests likely to be found on site in the spring and early summer. The catches on the sticky traps were checked and recorded during the inspection. Insects known to be museum pests were caught.

KLSE museum curator Brooke Childrey was the principal park contact person for the project during the site visit. During the IPM survey, Brooke Childrey, her collateral duty curatorial staff, and the new park IPM Coordinator were trained in insect identification, pest management options, and use of the computerized pest monitoring database program. Barbara Cumberland also met with the non-NPS facility manager. It is important for all KLSE staff to be aware of IPM issues and how they impact the park's resources as most staff members and the facility manager will have some role in the IPM process.

Careful situation analysis is necessary so that the causes of pest problems, rather than the symptoms, are treated. Knowledge of pest life history characteristics (e.g. life cycle, habits, habitat, and food preferences, etc.) is a prerequisite for successful pest control and sometimes this information must be inferred on site through careful observation. The mere presence of a known pest organism does not necessarily constitute a pest problem. Exotic species, though undesirable in natural areas, are not always pests, while native species out of balance in a disrupted ecosystem can become pest problems. Prevention of pest infestation, or simply the maintenance of pest populations at acceptable levels, is the preferred strategy, since it can often be accomplished through non-chemical means. When chemicals are necessary, they are more effective when used in combination with other non-chemical means (e.g. mechanical, physical, biological, and cultural, etc.). Monitoring the relative success of individual treatments and documentation of control efforts are important follow up activities, which enable an IPM program to learn from its mistakes and build on accumulated successes.

What is Integrated Pest Management? "IPM is a decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage,

by cost-effective means, while posing the least possible risk to people, resources, and the environment." (NPS Management Policies 2006).

Integrated Pest Management was mandated by Presidential Directive in 1979 as the method by which all federal agencies must handle pest management on federal properties, including leased properties. From this directive, the National Park Service (NPS) began developing IPM programs that specifically address the unique needs of culturally and historically significant properties, as well as unique ecosystems. This approach relies on cost-effective and site-specific pest controls, decision-making processes, and risk-reduction systems to manage, rather than eradicate, pests. It depends on knowing what pests are present and knowing their biology and habits. The IPM approach is more effective than traditional pest control methods using chemicals because it combines tactics like sanitation, monitoring, exclusion, habitat modification, and (only when necessary) judicious use of specific pesticides. The National Park Service *Museum Handbook, Part I, Chapter 5: Biological Infestations* can be referred to for guidance on the IPM process.

Developing and implementing an **Integrated Pest Management** strategy in the National Park Service follows an **eleven-step process**. These steps are **cyclical** and **ongoing**:

1. Describe your **site management objectives** and establish short and long term **priorities**.
2. **Build consensus** with stakeholders- occupants, decision makers, and technical experts.
3. **Document** decisions and **maintain records** of activities, monitoring, successes, and failures.
4. **Know your resource** (site description, ecology, and resource assessment).
5. **Identify** current and potential **pest** species, their biology, and conditions conducive to support the pest(s).
6. **Monitor** pests and environmental conditions.
7. **Establish action thresholds** at which point an approved management strategy will be implemented.
8. **Review** available tools and **best management practices** for the management of the identified pest(s). Tools can include: 1) no action, 2) physical (manual & mechanical), 3) cultural, 4) biological, and 5) chemical management strategies.
9. **Select** the most effective, low risk pest **management strategies** in accordance with applicable laws, regulations, and policies.
10. Obtain approval, define responsibilities, and **implement** selected **best management strategies**.
11. **Evaluate results** of management strategies; determine if objectives have been achieved; modify strategy if necessary; outreach and education.

Objectives of the Museum Collection IPM Plan

This IPM plan for the KLSE museum collections should be used as a working document for the park staff and contains information on general program guidance, describing the biology and management alternatives for pests often found in museums. It also includes literature references, sources of pest control supplies, and other pertinent IPM information. The value of the IPM Plan to the park will increase if, through periodic review and revision, it is updated to continually reflect changes in pest management technology, locally available expertise, input from park divisions, and remains a long-term consensus of pest management activities in the park.

All actions to eliminate, reduce, or prevent the presence of pests in the collection areas of park exhibits and the museum collection storage areas, and prevent potential loss of resources should focus on:

- Reducing and managing pest populations by limiting food, water, harborage, and environmental conditions that support them.

- Making buildings, storage, and display areas as pest-proof as possible while still preserving historic objects, historic structures, and appearances.

To achieve these pest management goals, the objectives of this Integrated Pest Management Plan for the museum collection are to:

- Protect all museum collections from damage by pests.
- Minimize risk of damage to collections from the corrosive and aging residues of applied chemicals.
- Define the roles and responsibilities of persons having pest management duties and provide written guidelines to enhance program success.
- Provide the park with a pest monitoring program, including a computerized database for recording monitoring data for the park's permanent records.
- Identify pest problems and develop action or threshold levels (population or damage levels where the presence of pests or environmental conditions indicates management actions must be taken).
- Provide rational, safe, effective IPM alternatives for managing museum pests by describing the necessary actions to modify environmental conditions, accomplish pest exclusion, and otherwise make sites incompatible for pests.
- To minimize the tendency to rely on pesticides and to establish that only pesticides approved by the NPS will be used when absolutely necessary. Pesticides selected will be the most effective, be used when pests are in the most vulnerable stage of development, and pose the least hazards to people, resources, or the environment.
- Establish the importance of periodic site inspections and monitoring that determine whether action thresholds are being exceeded or if previous pest management actions were effective.
- Emphasize the value of written pest management and monitoring records in evaluating the results of habitat modifications and pesticide treatments.
- Establish a policy for new accessions to facilitate pest management.

Pests are living organisms that interfere with the purposes or management objectives of a specific site within a park, or that jeopardize human health or safety (*NPS Management Policies* 2006). At KLSE, the management objectives at risk from pests are the preservation and interpretation of historic objects for future generations.

The term **"museum pests"** refers to a broad array of both vertebrate and invertebrate organisms that can invade collections and damage such items as furnishings, art work on paper or canvas, archives, textiles, archeological and ethnographic items, historic objects, and natural history specimens (see Appendix A, *Action Plans for Pests*). Most museum pests are arthropods with biting mouthparts that damage objects in collections by feeding on them; however, these pests can also damage items with their excretions or secretions. Mice, rats, and other vertebrates are other pests in museums and historic structures that directly damage articles or indirectly threaten entire collections by gnawing on electrical wires, which can result in structural fires. Sometimes, even otherwise harmless and dead creatures (i.e., dead mice or flies in rooms, wall voids, or attics) can indirectly affect collections when their decomposing bodies attract museum pests such as carpet beetles that later invade collections. Microorganisms, such as mold, are also museum pests. Consistent preventative measures should be taken in museums against all pest invaders, not just those posing obvious threats.

LEGAL AUTHORITIES AND REQUIREMENTS

National Park Service (NPS) policy establishes IPM as the preferred method for managing pests in park units and development of this program is based on and directed by various policies, laws, regulations, executive orders, and a presidential memorandum. Some of these include:

As stated in 7 USC 136r-1, "Federal agencies shall use Integrated Pest Management techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies, and other activities."

President Carter's 1979 Presidential Memorandum directed all federal agencies to adopt IPM strategies wherever practical. Departmental and many of our own policies instruct us to adopt IPM strategies and plans, including 517 DM 1, 30 AM 12, 7 RM 14, and 620 FW 1.

State Regulations on Pesticide Use
The State of Washington requires Federal employees who apply restricted-use or state-limited-use pesticides by any means to be licensed as a Pesticide Applicator or be supervised by a certified Pesticide Applicator. Certified Pesticide Applicators must receive at least 6 hours of approved pest management continuing education each year to maintain certification.

The laws and regulations of the State of Washington which govern the general use of pesticides are set forth in Washington Administrative Code 16-228 and found in the Washington Pesticide Application Act (RCW 17.21) and the Washington Pesticide Control Act (RCW 15.58). For a copy of state pesticide regulations and certification testing, contact the Washington State Department of Agriculture, Pesticide Management Division, P.O. Box 42589, Olympia, Washington 98504-2589; E-mail *license@agr.wa.gov*; telephone number 360/902-2020 or toll free telephone 877/301-4555.

Other Federal Laws and Regulations
-Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947; amended by P.L. 92 516 (82 Stat. 973) and P.L. 94-140 (89 Stat. 751)
-Federal Environmental Pesticide Control Act of 1972 (7 U.S.C. 135 et. seq.)
-President Carter's 1979 Executive Order requiring all Federal Agencies to use integrated pest management technology for pest control and to reduce use of toxic pesticides
-President Clinton's April 26, 1994, Memorandum concerning economically beneficial practices on Federal landscaped grounds
-Secretary Babbitt's July 12, 1994, Memorandum concerning the Department of Interior and the Federal Insecticide, Fungicide, and Rodenticide Act
-Executive Order 11870 concerning Animal Damage Control
-Executive Order 11987 concerning Exotic Organisms
-Executive Order 12088 concerning Pollution Control
-Resource Conservation and Recovery Act (40 CFR 165) dealing with pesticide disposal
-Migratory Bird Treaty Act
-Endangered Species Act
-Occupational Health and Safety (OSHA) Hazard Communication Standard (29 CFR 1910.1200) and -Respiratory Program Standard (29 CFR 1910.134)

NPS Management Policies, updated 2006
Implementing IPM practices in NPS field areas has been a service-wide goal since 1979. Information describing the design, application, and evaluation of park IPM programs (and regulations and policies governing them) are found in Chapter 2, Integrated Pest Management, of NPS-77, the NPS Natural Resources Management Guidelines.

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

Chapter 2: Vegetation Management; Native Animal Management; Freshwater Resources Management; Endangered, Threatened, and Rare Species Management; Exotic Species Management; Hazardous Waste Management; and Public Health and Safety
Chapter 3: Agricultural Use, Right-of-Way and Easements, and Backcountry Recreation Management
Chapter 4: Environmental Compliance
Chapter 5: Special Use Permits and Collections

REVIEW OF PAST PEST MANAGEMENT METHODS AT KLSE

There was no prior written approved IPM plan for Klondike Gold Rush National Historical Park-Seattle Unit. However, the former museum curator and current collateral duty curatorial staff conducted pest and environmental monitoring in the collection storage room between 2002 and 2009 (including the park's previous location). Soon after the NPS moved into the Cadillac Hotel, *"Integrated Pest Management Survey and Recommendations for the Klondike Gold Rush National Historic Park"* was written by museology intern Dawn Roberts to document the IPM situation in early 2006.

There was no IPM Coordinator at the park before June 2009. The park curator would deal with any museum IPM issues that came up in collection storage or exhibit spaces. No Pesticide Use Proposals (PUPS) have been initiated for KLSE. Kji Kelly, the facility manager that works for the building owner, Historic Seattle, deals with pest management issues building-wide, particularly the early infestation of Norway rats. Park guide David Wymore is the NPS liaison with the Historic Seattle facility manager. David Wymore was selected as the KLSE IPM Coordinator in June 2009 during the development of this *Museum Collection IPM Plan.*

When the park first opened here in 2006, there was noticeable evidence of infestation of Norway rats throughout the building. The building manager hired a commercial pest control company to set and monitor traps (Orkin), and this contract is ongoing. According to building occupants, the rats were controlled soon after intensive trapping was initiated in 2006. It is said that the rat infestation had become established during the reconstruction after the 2001 earthquake, and that rats were using the structural inverted metal "V-beams" with openings at the top of the lower ends as runways when the NPS first moved into the building. In some offices, people used duct tape to seal these openings and that also seemed to help. Since then, there has been little evidence of infestation. At the time of the June 2009 IPM inspection, there were rat snap traps set in the areaway and rat bait stations set in the alley against the west side of the building. These traps are currently maintained by Orkin once a month. Monthly Orkin records are kept by the facility manager and a copy is given to the on-site curatorial person. In recent years few rats were caught, occasionally in the areaway. There were also some old rat snap traps (some set and some not) found in offices on the second floor, but these are no longer maintained by Orkin or anyone else.

The park has a *Museum Preservation Maintenance Plan* (2007) that includes written museum housekeeping procedures that are an essential component of museum IPM. The collection storage areas and the exhibits should be maintained in clean, uncluttered condition. Curatorial housekeeping is done by the curator and the park staff with collateral curatorial duties. There are forms that are filled out for tasks done on a daily, weekly, monthly, quarterly, semi-annual, and annual basis both in collections storage and

exhibits. Most of the tasks involve sanitation or museum environment, and have either a direct or indirect impact on IPM. (See Appendix I). There is a binder kept in the collections storage room with "Museum Preservation Maintenance Plan Worksheets: Daily Tasks, Weekly Tasks, and Monthly Tasks".

Prior to the 2009 IPM survey, pest monitoring has been done only in the collections storage room at KLSE with insect sticky traps, checking and recording traps bi-weekly. The collateral duty curatorial person filled out the "KLSE Collection Storage Pest Monitoring Log" on a clipboard kept in the storage room. The pest descriptions were often not specific enough (e.g.: "flying insect", "small beetle-like insect", and "crawling bug"). This was a running list of the six sticky traps in storage by date. Another form was recommended in the 2007 *Museum Preservation Maintenance Plan* that was a "Museum Pest Monitoring Record" form for each different trap number/location (see both forms in Appendix I). Both of these forms will be replaced by the pest monitoring database developed in June 2009.

It had previously been decided that the park would allow visitors to bring food and drink into the visitor center exhibits, the classrooms, and to after hour events in the theater and exhibit areas. There are functions involving food every week or so. Presumably there is special cleaning following these events but it was unclear how this was accomplished (were notes left for the janitorial cleaners?). Some of the staff also eat in their offices and at the library table on the third floor. There was no written policy prohibiting food and drink in rooms that might hold museum and library collections throughout the building but this is recommended. Signs should be posted on the doors to the collection storage room, library, and visitor center stating that food, drinks, smoking, and live plants are not allowed. If strict hygiene and housekeeping standards are not adhered to, food, drink, and plants increase the risk of insect, rodent, and microbial activity.

Fortunately, many of the artifacts on exhibit are enclosed in tightly sealed cases.

Park staff reports that there are no major insect infestations or problems. There were no known pests on collections. Fruit flies were noticed in staff offices which are related to food and plants allowed in the offices. When asked about birds and bats, it was reported that there are seagulls that alight on the roof, and a bird nest on the building above the front door. Bird nests and wasp nests must be promptly removed from the building when they are noticed. Bird feathers are found in the areaway under sidewalk but no obvious bird droppings. No bats have been reported.

There had been two major water infiltration problems in the building since the NPS moved in. The HVAC system on the roof leaked into the library, and there was a fire hydrant leak outside the first floor that caused problems with the exhibits on two floors and mold in the basement. Water can lead to higher wood moisture content in structural elements, making them prone to attack from rot or wood-boring insects, or mold spores that attract insects like booklice, fungus beetles, and moisture pests like silverfish. Extra monitoring efforts must be concentrated in areas following water leaks.

2009 Site Visit Findings and Recommendations

In May 2009, in preparation for the June IPM survey visit to the park, the staff placed sticky traps in the exhibit spaces and the collection storage room and a few surrounding rooms on the first floor and basement of the Cadillac Hotel to give an idea of arthropod pests currently in the building. When checked in June, some of the traps

contained insects considered to be museum pests (booklice, silverfish, confused flour beetle, and evidence that a dermestid larva ate part of another insect).

All four floors of the building were physically inspected to determine the existing conditions. Each room was inspected for pest evidence, areas of potential pest access, and susceptible objects. Most museum collection objects in storage and on exhibit were inspected. Exterior features and relevant landscaping were examined. At the same time, additional insect sticky traps were put out around the building for future ongoing pest monitoring. The following notes on some of the rooms will summarize the reports of pest activity from staff members and examination of pest evidence gathered during the trial monitoring period of May through June. The detailed results of pest monitoring in rooms are in the reports in the KLSE *Museum IPM Notebook* initiated for this project, and in Appendix B.

The Cadillac Hotel building was built shortly after the Great Seattle Fire of 1889 and was in existence during the Klondike Gold Rush period. The building remained a hotel until 1970. Since the 2001 earthquake when the building was badly damaged, the Cadillac Hotel has been owned by Historic Seattle. The NPS owns the land that the building is on. In 2005, the Klondike Gold Rush National Historical Park, Seattle Unit moved into the building and the visitor center opened to the public with temporary exhibits in 2006. Now, in addition to long term exhibits in the visitor center on the first floor and lower level, the building has offices for the National Park Service or its partners, with the NPS Pacific West Regional Library on the third floor, and the Columbia Cascade Region Lands Division and a cooperating association (Discover Your Northwest) on the second floor. NPS offices are also on the third floor.

The Cadillac Hotel is in an urban Seattle neighborhood and is a solidly-built brick building since its renovation after the earthquake in 2001. There is no vegetation immediately adjacent to the building, which is an advantage for IPM since plant material and mulch are a habitat for pests. There was a restaurant next door that might attract pests to the area.

Lights are left on in the theater all of the time and lights are on all night outside the front entrance. Be aware that many insects are attracted to lights, so these areas may need closer monitoring.

BASEMENT

The basement (or lower level) will be monitored with insect sticky traps in many of the rooms because both exhibits and the collection storage room are on this level.

The **collection storage room** is located in the basement in Cadillac Hotel. The room is on an exterior wall with only a single sheet of wallboard separating the collections room from the ventilation areaway and the outside. There is no insulation between the areaway and collections storage and the areaway can become very damp and is open to exterior air movement, outdoor conditions and a large street level grate where rodents and other pests can easily enter. The areaway has conduit overhead that can act as a

runway for rodents. It has had a roof leak the previous year, and is inspected four times per year. There are no windows in the collections room. Temperature, relative humidity, and moisture content of objects have a bearing on pest activity. Generally, pest and microbial activity are reduced at lower temperatures and lower moisture contents. The room is supposed to be kept cool (64 degrees F), which will help deter pests. The collection storage room has a separate thermostat system from the rest of the building and is being monitored by a datalogger. Relative humidity (RH) should be kept moderate (50%) for the benefit of the artifacts and to deter moisture-loving pests and mold. However, the temperature and relative humidity usually do not remain close to their targets and fluctuate widely, especially the RH. The wide swings in both temperature and the relative humidity in the collections room indicate that it is being affected by its proximity to the areaway and outdoor environment. Ideally, both the temperature and RH should be constant year round. However, such conditions are very difficult to achieve within a historic structure, especially one located within a marine environment such as Seattle**.** The current building-wide HVAC system has been unable to provide a stable museum environment here. Keeping the relative humidity well below 65% is the most important way to control mold outbreaks. Keeping the RH low will also reduce moisture-dependent insects like silverfish. Environmental monitoring will determine if and when additional dehumidifiers or humidifiers are needed.



"Areaway" adjacent to basement

Serious consideration is being given to relocating the collection storage from its present space to the Prospector room that is an interior space away from the building's outer envelope and the damp areaway under the sidewalks. This is a good option. If the collection storage room is moved to a different space, refer to Appendix H for IPM guidelines for construction of museum spaces.

Due to the difficulties inherent in achieving an "ideal" museum environment within a historic structure, the park is encouraged to house all collections in storage within enclosed cabinets. The more barrier layers to pests, the better. Properly sealed museum storage cabinets provide an important level of protection from the various agents of deterioration; their success in "buffering" such conditions and excluding pests is widely recognized. A majority of the collections are stored in cabinets. Some objects are stored in NPS-approved steel cabinetry that is well sealed against pests.

These gasketed cabinets should be the first choice for storing objects that are particularly pest-susceptible. The tall cabinets (E and F) holding document boxes are not gasketed. Some objects are on top of cabinets. Many of the cabinet drawers and specimen trays are lined with quarter-inch white polyethylene foam sheeting, which is a good background for showing evidence of pests**.** Most cabinets are raised at least four inches off the floor which is good for IPM reasons for cleaning beneath and noticing and monitoring for pests. The ceiling is black, which may make it more difficult to notice pests and spider webbing. The present storage room is carpeted, has sheetrock walls, and sprinkler pipes near ceiling.

The paper archive collections and library materials are susceptible to damage by cockroaches, silverfish, cigarette and drugstore beetles, dermestid beetles (carpet beetles, larder beetles, and hide beetles), molds, booklice, and rodents. The textiles may be vulnerable to many pests including dermestids, spider beetles, drugstore beetles, clothes moths, cockroaches, crickets, silverfish, mold, and rodents.

All of the collections were inspected during the IPM survey for pest evidence, except the archives in Cabinets E and F that were randomly inspected before they were transported to MORA on 6/18/09 for summer processing. In Cabinet F, there are paper archives in document boxes and the Hilscher Collection was randomly inspected, and Box 15 of 16 smelled of mildew. The archives taken to MORA will be thoroughly inspected there.

Cabinet B had a strong odor when it was opened. In Drawer 5, there was a dead insect on the Ethafoam pad next to the wood handle of KLSE 208. It appeared to be part of an anobiid larval skin or pupa. The drawer held mixed materials including leather, wood, metal and a textile bag. The case has a good gasket.

In Cabinet C, the cabinet has a good gasket around the edge, but a deteriorating gray foam gasket between the two doors. This can be replaced with new gasket.

On top of cabinet G (the rare book cabinet), there are rolled documents, blueprints, and Cadillac Hotel plans out in the open. One had spider webs inside the roll. The rolled documents should be enclosed in a cabinet, if possible, to provide an additional barrier layer to pests.

The curatorial storage room has a good double brush door sweep, although some light can be seen around the open side of the door; the doorframe overlaps the door, but adding gasket or weather-strip would exclude pests better.

Inspection of Lower level exhibits

The Visitor Center exhibits are located on the first floor and the basement level. One side of the basement level exhibits backs up against the areaway and in some places has only ¾ inch wallboard to separate the exhibits from the areaway. This areaway is an underground passageway with direct access to the street (stairs going up to a very large sidewalk grate). The areaway is regularly exposed to outdoor climate conditions and water from rain coming from above through the street level grate and also possibly migrating up through the ground. The areaway was being used to store miscellaneous boxes, equipment, paint cans, and other materials. Rats, other rodents, and pests have inhabited the areaway. Orkin monitors the areaway with snap traps for rats that are checked once each month. The areaway is likely one of the major paths of pest entry into the building.

Many of the exhibit objects, whether cataloged collection objects, props, period pieces, or reproductions are of materials attractive to pests (wool clothing and blankets, shoes, paper, leather, other textiles). Original, reproduction and period pieces are treated as museum collections.

On the lower level, the exhibit space has a concrete floor. All collection objects were inspected and most were in good condition for pests with the exception of those in *Pest Incident Reports* in Appendix C.

The Filson exhibit with the Filson mannequin with wool outfit is next to Nordstrom shoe exhibit, which were carefully examined. The shoe exhibit case is well sealed except for where there is a hole in the case bottom for the fiber optic bundle. There is tape partially around the hole but it could be better sealed, possibly with clear caulking. One of the leather shoes had holes and grazing from insects such as dermestid larvae (may be old damage). No other pest evidence was seen. It is recommended that the wool clothing on the mannequin and the shoes be closely inspected at least annually.

The Fraternal organizations exhibit case (LL #2) has materials that would be attractive to pest- textiles, silk sashes, paper, banners) but looked in good condition.

The mock log cabin exhibit, has a variety of materials like the "stack of firewood", canvas clothing hanging against cabin wall, wool blanket on shelf in open, and books "piled" in open. The wool blanket was found to be infested with numerous live clothes moth larvae and a varied carpet beetle larva, and had dead adult moths and pupal casings. The wool blanket will go through the freezer treatment to kill the live infestation, have the pest debris vacuumed and picked off, and the shelf it was on was thoroughly vacuumed. The cabin wall case (LL #5) was opened for inspection and the artifacts looked good, although there were spider webs inside the rough wooden case that is fairly well-sealed. The pest susceptible objects in that case to inspect periodically are the two leather bags and a paper booklet.

The logs and wood for the mock cabin was thought to be treated for pests before installation. A Wagner L606 moisture meter was used to test the wood moisture content (wmc) of the structural wood because wood with a wmc of less than 12% are less likely to become infested than those with higher moisture content. The cabin logs and other wood in the exhibits tested at a lower wmc of 10% or less (probably kiln-dried), making it less attractive to woodboring insects.

There were live spiders and webbing on the "boat" (LL# 6). The boatbuilding exhibit is problematic to keep clean because there is loose sawdust left around as part of the exhibit.

The "Grub box" and sleeping bag exhibit case has a ¼ inch opening between the sliding glass doors where insects or mice could enter. The sleeping bag is filled with feathers and is susceptible to pests like clothes moths and dermestids. The case was opened and these objects were inspected in situ and no pests were found on the sleeping bag, but it is recommended that it be given a precautionary freezer treatment and vacuumed. There may have been frass on the shelf around the grub box.

Other exhibits that were inspected and found to have no problems were the doll case, the red wool cape out in the open, and the props including sleds with boxes and cloth bags.

Under the central stairs from the first floor to the lower level in the exhibits, the concrete floor is covered with large rounded stones. This area has accumulated a lot of dirt, lint debris and some spider webbing between and under the loose stones. This has become a potential area for a lot of pest harborage because the stones are never cleaned or disturbed. The lint and "dust bunnies" consist of material that dermestid larvae and other museum pests could feed on. A new sticky trap was added here to monitor. The rocks need to be cleaned by temporarily moving aside sections of stones and vacuuming them and the floor with a HEPA filter vacuum with a round brush attachment (wearing gloves). This is never done by the contracted cleaning crew, so it would either be a special cleaning job for them or somebody else that might only need to be done once per year. Sean O'Meara suggested that this might be a good project for a Boy Scout troop.

Other rooms. The janitor closet has water heater, drain basin, wires and pipes, and cleaning materials, and was in clean condition. This room and the shower room next to it should be maintained with clean drains to avoid a problem with moth flies (drain flies).

The elevator machine room has two vents high on the wall, and a bag of trash was hanging inside on the wall. Trash should not be stashed in that room where it can be forgotten.

The mechanical room (fire alarm control panel room) has brick walls and sheetrock, wire, pipes, concrete floor, had cobwebs around gauges and apparatus, floor drain. Most, but not all ducts are sealed. There were cracks between floor and brick wall. A sticky trap was placed in this room to monitor to see if the numbers of arthropods getting in signify the action threshold for cleaning and sealing the cracks and holes better.

Next to the collection storage room is a storage room for the bookstore, as well as general storage for the park. This room has the door with access to the areaway, so it is monitored with sticky traps to see if any pests might be coming into the basement from the areaway.

FIRST FLOOR (Upper level exhibits)

The front entry door to the KLSE visitor center first floor exhibit room is sometimes left open during the summer, allowing pest entry.

The temporary exhibit room has a large horizontal case, a "Guess what?" case, a recent acquisitions case and open display. Costumes were being prepared for exhibit out in the open on mannequins in the temporary exhibit gallery on the first floor. These were period costumes that are on loan from Goodwill, and Goodwill said there were moth problems in the facility that the costumes came from. The costumes were inspected and no moths were found, but they should continue to be monitored. A 5x5- inch glass pane is broken in the temporary exhibit room that should be repaired.

The gift shop will be monitored with at least one sticky trap. It has a door directly out to the exterior of the building.

The following are some of the types of collection objects and props in the rooms that should be inspected periodically (and were inspected during the site visit) because they are pest-susceptible organic materials: paper, books, documents, newspapers, leather, wool clothing and blankets, silk, cotton textiles, snowshoes, felt hats, feather-stuffed sleeping bag, fur, wood, furniture, cardboard boxes, doll, bags on sleds, trunk, shoes, barrels, leather pouches an goods, leather on camera, library books, etc. The "General Outfitters" store exhibit has objects out in the open that are vulnerable to damage by clothes moths and dermestids such as wool clothing and blankets. These are frequently touched by visitors so it is difficult to put sticky traps near them, so they need to be frequently inspected (once a month) since these pests are known to be active in the building. Clothes moth evidence was found on the wool blanket; the other first floor exhibits had not pest problems during the inspection.

Placing heavy-duty floor mats at the interiors of the entrances to limit tracking in dirt and insects is recommended.

Stair 1 at the first floor level has an emergency exit out to the alley and a small gap can be seen under the door. Install an effective door sweep.

The pest management contractor, Orkin, has placed five Protecta LP Bell Rodent Bait Stations in the alley immediately against the building on the west side exterior. Poisoned rodents could have easy access to the areaway through the sidewalk grate, so rodents could die down there and attract dermestids or other scavengers before the Orkin people make their monthly inspection. On the alley side, there is a horizontal crack in the mortar missing near the pavement that might possibly have holes into the building interior.

No vegetation touches the building.

SECOND FLOOR

The second floor houses the Lands offices, and for the most part will only be monitored with "Observation Log" entries in the database at first. Staff should be told to notify the IPM Coordinator or curatorial staff if any pests or evidence is seen so that it can be documented and evaluated for management actions. The filing cabinet room and several of the offices have sticky traps because the occupants wanted them in there. Food is seldom eaten at the conference table. There were some old rat snap traps in corners of some offices from back in 2006 when there had been rat problems, and some are still in place although not being maintained. Some of the holes at the bottom ends of the diagonal struts have duct tape over the openings to exclude rats from using them as rodent pathways. This would be a good idea to do throughout the building. Be aware that there are large openings under the office doors

where pests including rodents can go between rooms. Any rooms that may have museum or library collections should have these gaps blocked with effective door sweeps.

The janitor room has janitorial supplies and a drain basin. Pipes are well sealed where they go through walls and ceilings. All places with floor drains or basins with drains should be inspected or monitored to see that moth flies (drain flies) do not become a problem.

THIRD FLOOR

The third floor houses the NPS offices, and the NPS Pacific West Regional Library. The library has plastic over the stacks following a leak from HVAC on roof. The library has drop ceilings on part of it and a skylight in the center. The staff reported that the only pests are flies, no other bugs, but it had not been previously monitored with sticky traps. The staff often has the windows open with no screens. The windows need to have screens. There are many live potted plants in the library and in many offices which are not recommended because they provide what pests need to survive: food, water, and harborage. In the saucer tray under a plant pot at the library west window, a live booklouse was found, which is typical around potted plants, but detrimental to introduce into a library.

Sticky traps were placed in the library and the adjacent library offices because this is a target area in this IPM Plan. The goal is to protect the books and reference materials from pest damage. Some of the staff also eat food in their offices and at the library table, which again, would be a good policy to change.

Insect sticky traps were put in some of the NPS offices for continued monitoring because those rooms could potentially have collections being researched or worked on there, or they have important museum records and files stored there. The windows were open in these staff offices, with no screens, providing direct access for insects. Any of these windows that are opened need screens to exclude insects (see Suppliers, Appendix E).

The other rooms without sticky traps will only be monitored with “Observation Log” entries in the database.

The janitor closet has a vent, pipes, and a drain in floor. This closet must be kept clean and dry, and the drain kept clean to avoid moth flies (or drain flies, see Appendix A).

The break room (kitchen) will also be monitored with sticky traps because it has a refrigerator, microwave, sink, coffeemaker, toaster, and food. Kitchen rules are posted for sanitation. Adding tight-fitting lids on the trash can and recycling container is recommended.

Stair 3 ladder to roof shows a spot of daylight at the roof that should be blocked.

ROLES AND RESPONSIBILITIES

Superintendent

The superintendent has ultimate responsibility for the park IPM program and should make every possible attempt to provide staffing and funding to effectively carry out a proactive museum IPM program and to support the necessary pest monitoring, inspection, exclusion, housekeeping, and other pest management

needs. Updated training should be provided when available. It is recognized that trained employees and long-term program continuity are very important to the success of the KLSE museum IPM program.

Park IPM Coordinator
David Wymore, Park Ranger (facilities liaison, park safety officer, phone: 206-220-4236) is the new IPM Coordinator for KLSE. Prior to the June 2009 IPM Plan site visit, there was no KLSE park IPM Coordinator.

It is recommended that park IPM Coordinators receive 40 hours of initial Servicewide IPM training and be certified as a pesticide applicator in their state of residence. At this park, the certification as a pesticide applicator may be optional, and perhaps the regional IPM coordinator in Seattle could be called on to assist or supervise if pesticide application is needed.

The general responsibilities of a park IPM coordinator are addressed in *NPS-77 Natural Resource Guidelines, Integrated Pest Management* (soon to be updated by *Director's Order 77-7*).
The park IPM coordinator is responsible for establishing pest management priorities for the entire site, not just museum areas. The park IPM coordinator is responsible for assisting the curatorial staff with pest problems, reviewing museum pest monitoring reports periodically, and providing training to employees assigned to pest management duties. Any and all pesticide use must be approved in advance and all uses must be reported at the end of the calendar year to satisfy NPS legal requirements and for consolidation into the NPS Pesticide Database. Pesticide projects originate with park staff. The park IPM coordinator provides the first of three levels of review (park, region, and Washington Office) required for all pesticide projects before final approval may be granted by the service-wide IPM coordinator.

Park IPM coordinators should recognize that they are in the best position to provide the closest level of scrutiny and to respond to questions and concerns raised by the regional and service-wide IPM coordinators. The park IPM coordinator is responsible for using the NPS Intranet Pesticide Use Proposal Program (PUPS), annually reporting the park's Pesticide Use Log, and keeping copies of labels and MSDSs of any pesticides used. The IPM coordinator should be responsible for informing pesticide applicators, whether in-house or contracted, about NPS policies concerning pesticide use; monitoring applicators for safe application; and ensuring applicators follow label precautions and application guidelines. The IPM coordinator should consult the curator or cultural resource manager before using any pesticides around museum objects or on historic structures. He should make the information on pesticides used or areas treated in the park available to both the public and employees.

The park IPM coordinator can assist with pest identification as part of the recommended passive monitoring with sticky traps. He will assist the point-of-contact curatorial person with conducting the pest monitoring program. He should help to interpret the results of the computerized pest monitoring reports, and work with the museum curator to recommend and implement low-risk pest management actions based on the results of inspections and passive monitoring. He should maintain and continually update (as new information is available) permanent files for each new pest listed in the IPM plan. New pests of concern to the curatorial staff should be identified through continued monitoring year round. The IPM coordinator should write and update the general park IPM plan every five years or as needed; provide IPM training opportunities (including informative memos) to the facility manager, resource management, and general staff; participate in prioritization and evaluation of IPM work requests, and assist in design of treatment strategies in consultation with the facility manager and curator.

Regional IPM Coordinator
Erv Gasser, The IPM Coordinator for the Columbia Cascade and Pacific Great Basin Clusters in the NPS Pacific West Region, is located at 909 First Avenue, Seattle WA 98104 (email: Erv_gasser@nps.gov, phone: 206-220-4263). His office is conveniently close to the park. The Pacific West IPM coordinator serves KLSE and also serves as a liaison between the park and the service-wide IPM coordinator to provide IPM training and information to develop management strategies, keep the park apprised of changes in policy or pest management technology, review proposed pesticide application programs and projects, and confirm that proposed uses of pesticides are essential within an IPM strategy. The regional IPM coordinator gives approval or disapproval to the park IPM coordinator for Pesticide Use Proposals (PUPs). He provides IPM advice to the parks in the region.

Curatorial Staff
At KLSE, the museum curator of record Brooke Childrey has been given the primary responsibility for administering the museum IPM monitoring program. The museum curator has pest management duties that are important to both the preservation of museum objects and the overall success of the park IPM program. Brooke Childrey has been the curator of record since October of 2008, and is stationed at Mount Rainier, and only spends twelve days per year at KLSE. At KLSE, Tim Karle is the curatorial day-to-day point of contact on site. He is the curatorial liaison as a collateral duty, not a full-time museum person. Museum IPM is a collateral duty for this year-round permanent employee. He will assist the park IPM coordinator with conducting the pest monitoring program, and do most of the data entry into the monitoring database. There is also a part-time seasonal museum technician and museum intern, and other interpretive staff that sometime assist with curatorial functions as collateral duties.

At least semi-annually, the museum curator and her collateral duty curatorial staff or interns should thoroughly inspect the museum storage areas, research spaces, visitor center exhibits, the library, and other rooms that might hold collections and note any harborage available to pests, evidence of pests, damage to museum objects, and structural deficiencies or conditions encouraging pests. The museum objects are inspected at least during the annual inventory and during routine housekeeping that should be performed on an ongoing basis. Inspections should record and flag needed repairs/ maintenance, and these deficiencies should be noted on structural floor plans. Additional spot inspections may take place as dictated by need. The curatorial staff should continually monitor the museum storage and exhibit areas for evidence of pests using sticky, light, pheromone, or snap traps, and observations.

Completed inspection and monitoring forms should be filed in a permanent *IPM Notebook* and copies of the reports should be referred to the facility manager for follow-up action, such as work requests for structural repairs. Monitoring results should be shared with the park IPM coordinator and all staff members. These monitoring reports can be physically circulated to staff members or shared and discussed at staff meetings.

The museum curator (Curator of record or point-of-contact curatorial person) conducts routine and special housekeeping duties such as vacuuming in the collection storage and exhibit areas, because sanitation is an essential component of the IPM program. The curator can do this or enlist the help of maintenance staff, interpretive staff, interns, and volunteers as needed.

Facility Manager/ Maintenance Division
The maintenance division serves an extremely vital role in park pest management. Sanitation tasks, structural maintenance, and pest exclusion are an essential part of the IPM program whether performed by the building owner's staff and contractors, park maintenance staff, the curatorial staff, interpreters, other staff, interns, or trained volunteers.

At the Cadillac Hotel building, the facility manager Kji Kelly works for Historic Seattle. Historic Seattle contracts out maintenance, utilities, and repairs. Most maintenance duties related to the building are delegated to the Historic Seattle contracted janitorial service, and their cleaning of the building is limited in scope. The contracted building janitorial staff cleans daily, in the evenings after park staff leaves. They maintain the floors and railings (horizontal surfaces), but not the curatorial spaces. The park is responsible for exhibit maintenance and collection care. A curatorial housekeeping schedule is in the Museum Preservation Maintenance Plan. Park staff does the more detailed cleaning of exhibits and curatorial storage, but some sanitation tasks that are important to the IPM program get neglected due to staff time restrictions and lack of communication between park staff and the contractors. Many times, insect sticky traps get thrown away by the contracted cleaners, so it must be communicated to all of the janitorial staff that they can clean around the traps but they must be put back in place, especially now that there are more traps around the building. The park IPM Coordinator has been the NPS counterpart and liaison with the Historic Seattle facility manager, and he needs to clearly discuss with the facility manager about the museum IPM program concerns so he can make sure the contractors understand what is needed. The park staff and cleaning contractors should be alert to conditions and signs of pests and pest damage and, when found during routine maintenance, report such information to the curator, facility manager, and IPM coordinator (i.e.: rodent feces on floors, termite damage, animal burrows under structures, or evidence of bat roosts).

The facility manager should schedule routine maintenance of the buildings housing museum collections to aid in trash removal, cleaning, and removal of insect, bird, and animal nests from the building's exterior.

Historic Seattle, through the facility manager, has a contract with the pest management company Orkin to monitor and trap rats in the areaway, and the Orkin monthly reports are given to the facility manager. Now that the park has an IPM Coordinator and a *Museum Collection IPM Plan*, a copy of the Orkin reports should also be filed by month in the *Museum IPM Notebook*.

When necessary, the facility manager should schedule upgrades of the buildings to improve exclusion of pests through caulking, patching holes, screening, installing better door sweeps, etc. The maintenance division should punctually schedule repairs of all reported structural and utility deficiencies that support or encourage pests. Roof and plumbing leaks should be attended to as soon as needed. Water and moisture attracts pests and is necessary for pest survival. Water problems can cause fungal decay to wood and structural damage. Trash, especially food trash, should not be left in the buildings overnight. A historic architect or cultural resource specialist should be consulted to assist and advise on any pest control actions that may affect the historic fabric of the historic structures. This might include repairs for excluding pests or major structural pesticide treatments.

Combinations

Semi-annually (preferably in early spring and late summer), the museum curator, facility manager, and park IPM coordinator will, as a team, inspect the interior and exterior of the Cadillac Hotel (see forms in Appendix C). Findings should be recorded on archived inspection reports in the *Museum IPM Notebook*. When inspections show evidence of museum pest activity, monitoring activities should be increased and, based on the accepted action threshold, pest management actions initiated. The museum curator and/or park IPM coordinator should use findings from the inspection and monitoring reports to justify work requests for structural repairs that should be directed to the facility manager. The IPM coordinator should maintain a permanent file of work completed.

Curatorial, maintenance, and interpretive staff should meet briefly two or three time per year to review and evaluate pest management practices and coordinate activities. At least every three years, the superintendent, curator, and IPM coordinator should review the Museum Collection IPM Plan for possible changes or additions.

The entire park staff and volunteers should be alert to conditions supporting pests, signs of pests, and pest damage, and report any findings to the IPM coordinator, and/or curator. Staff meetings and/or memoranda can update everyone on museum IPM priorities so everyone can get involved. Any IPM actions and issues should be reported to the park curatorial person for documentation in the *Museum IPM Notebook* and Access database.

INSPECTION AND MONITORING

Pest management activities should never begin with pesticide application, but rather with inspections that identify the kinds and extent of pest infestations and their sources. There are usually reasons supporting every pest infestation: access points through which the pests entered, food and water to sustain them, and harborage where the animals live and reproduce. Discovering those reasons requires pest identification and knowledge of their biology, abilities, limitations, and habitats. "Inspection" refers to the initial discovery of pests or conditions supporting them. For example, inspection led to the discovery of a wool blanket on exhibit that had an infestation of live clothes moth larvae and carpet beetle larvae. "Monitoring" is to watch or measure conditions over time to determine if pest populations are static, decreasing, or increasing and then making judgments regarding the significance of those findings. Monitoring provides managers with baseline data, ways to compare one season with the next, tools for measuring progress and determining true costs, and reference points for all pest control decisions.

Identification

Identify and document species as specifically as possible, because they have different life cycles, food preferences, and habits. If possible, all pests observed in the museum and curatorial areas should be identified to genus and species. It will be useful to identify and document the species, especially of beetles and moths, to keep track of seasonal variation, life cycles, and spatial distribution around the site. Spiders do not need to be identified to species within museum structures, unless they are a species with a bite poisonous to humans (e.g.: brown recluse or black widow). Where pests cannot be properly identified in the park, they should be captured, preserved, and sent to a specialist for proper identification. Insect specimens can be brought to the University of Washington entomologist for identification, or can be sent to the Washington State Cooperative Extension Entomologist, or the USDA Systematic Entomology Lab, Beltsville, MD (see Appendix A). Some useful pest identification books are in the reference section of this plan.

The museum curator should keep and update a reference collection of dead insects to refer to for identification. Museum pests and other typical insects for the site should be kept in the reference collection. When insects are identified off-site, they should be sent back to the park for future reference. Small vials, tweezers, alcohol, and labels should be readily available to all staff to collect insect specimens for identification and possible addition to the reference collection. Larvae, worms, silverfish, and other soft-bodied insects should be preserved in covered vials in alcohol, while many beetles and hard-bodied insects can either be kept dry in a vial or in alcohol. The interpretive and maintenance staff should be encouraged to bring insect specimens to the museum curator labeled with the date, time, and exact location of collection.

Computer Database

A customized computer database for recording pest activity at KLSE was developed using Microsoft Access and given to Tim Karle and David Wymore. The museum curator and her collateral duty staff were trained on the use of the database during the site visit. KLSE has a shared database among the staff, and Tim Karle will do most of the data entry. All pest activity should be entered into this database. The museum curator and IPM coordinator will use this database to perform analysis to see if action thresholds are reached for management actions. It is hoped that this database will reveal areas and time periods of pest activity. Insect pests found in certain areas can serve as "indicator" species for poor environmental conditions, such as silverfish indicating moisture problems and high humidity. The computer program easily generates reports of pest activity for any date range, including reports for “total catch”, “museum pests” or any “individual pest”. Instructions for the computer database are found in Appendix B and the *IPM Notebook* along with lists and floor plans showing the locations of traps.

Inspections

Regular monitoring and inspections are very important to be able to recognize museum pest infestations as early as possible because these organisms are very adaptable and very prolific. Once insects invade a structure, control requires considerable time and can be difficult because small, residual populations can survive under even the most sanitary of conditions. Given opportunity, latent residual populations may suddenly explode into major problems. Inspections that find the sources of insect infestation and focus corrections on good exclusion, increased sanitation, and thorough building cleaning will generally control most insect problems.

A museum pest inspection requires a thorough search through the entirety of a building containing museum items. Items to be watched for include any evidence of pests, structural deficiencies or cultural practices potentially supporting pests, all potential food sources (fabrics, organic objects, etc.) and possible harborage sites (clutter, plants, bird or wasp nests, cracks and crevices) available to pests. Locations that are commonly overlooked include areas inside and under drawers, cabinets, and furniture; attics and store rooms where rodents or other animals may have made food caches; inaccessible wall voids holding dead animal carcasses; above drop ceilings; and inside electrical equipment and motors (including computers).

All personnel involved in rodent trapping or inspections that are brought into close contact with rodent debris should wear approved personal protective equipment and follow Federal Centers for Disease Control (CDC) guidelines. At a minimum, personal protective equipment should include rubber or latex gloves, hard hat (where appropriate), and a dust mask capable of screening particles as small as 0.3 microns in size (i.e., HEPA filter).

Because there are so many different kinds of museum pests and with different biology and living requirements, museum inspections should be extremely thorough. The inspector should be familiar with the various species and their preferred habitats (noted in Appendix A, "Action Plans for Pests"). Because of the size difference between rodents and insects, inspecting for insects requires the inspector to examine much smaller and more hidden areas (i.e., cracks and crevices, folds). A bright flashlight should be used in all pest inspections to help identify adults, larvae, shed larval skins or feces, and to evaluate harborage conditions. A magnifying glass is essential when inspecting and checking sticky traps, because there are some extremely small insects such as booklice and springtails that can be difficult to identify with the naked eye.

A bright flashlight should be used to search for pest harborage throughout the entire building. In search of mouse or rat harborage, talc can be sprinkled on the floor to detect mouse runs in rooms not open or interpreted to the public. Footprints in and around the talc will indicate where mice are active. The use of

a UV "black light" can be used in a dark room to detect trails of mouse or rat urine that fluoresce under black light.

Signs of museum pest infestations may include a number of things: discovery of shed skins, presence of feeding debris or frass around or below specimens, exit holes, feeding holes, hair falling from fur or pelts, missing pile from rugs, gnaw marks, pupal tubes or cases, moth or beetle pupae, cast larval skins of dermestids, flying adult or crawling larval insects, live or dead insects on windowsills, webbing, damaged organic objects (i.e., fabrics, hide, fur, feathers, horn, silk, wood, paper, etc.), flyspecks, infested or damaged food or food packaging, insects captured in pheromone or sticky traps or in ceiling light fixtures, nests, food caches, smudge or grease marks from rodents, droppings, odor, sounds, bait consumption, and burrows.

For additional information, see Appendix C of this Plan, "*Museum Inspection Sheet*" (prompts you to examine structural features) and "*Pest Incident Report*." One of these *Pest Incident Reports* should be filled out with the discovery of any pests, damage, or pest evidence **on a museum collection object**. The completed *Pest Incident Report* should be filed in the IPM Notebook and a copy filed with the object's accession record.

Continual monitoring of museum exhibits and collections is vital because of the speed by which museum pest infestations can develop. Specimens on display should be examined at least monthly for pests and pest evidence; and general museum collections in storage should be inspected at least twice each year. Sensitive articles (organic materials such as textiles, furs, feathers, etc.) should be examined more frequently. Accurate records should be kept on all monitoring activities. If infestations are found during monitoring, museum articles should be promptly removed or quarantined and pest management efforts initiated. Monitoring for pests will provide information on:

- Seasonal or temporal changes in the size or occurrence of pest infestations.
- Changes in the various factors that may periodically encourage pests.
- Post-treatment evaluation of the effectiveness of treatment strategies.
- New recommendations for improving the effectiveness of permanency of treatments.

Various procedures to be used for inspecting and monitoring for pests include:

Traps
Traps are a commonly used passive monitoring tool in museums. Insect sticky traps are not selective of the species caught and should not be used to control pests but rather to verify their presence and to evaluate the effectiveness of control measures. (See COG 3/7 in Appendix G). Food lures on sticky traps are not recommended for museum use. Many insect museum pests will be captured by these passive sticky traps that the staff would not be aware of without the use of these monitoring traps.

Sticky, light, or pheromone traps should be placed in areas where they attract and capture flying and crawling insects, and traps should be checked according to the schedule. All captured pests should be identified and the numbers, locations, and time interval over which they were caught should be recorded and put into the computerized database. The traps should be used to continually monitor for presence of insect pests in the display areas and museum storage, even when inspections have not identified the presence of pests. The traps are individually numbered and their locations recorded on floor plan diagrams with the numbers.

Other indications of the presence of pests (from reports by all employees, random inspections, etc.) should also be recorded in the computerized database, by rooms numbered in the database and on the floor plans as an "**observation log**" entry.

Sticky traps should be placed in areas of pest activity, against walls, near doorways, on windowsills, near water sources, and under fixtures and appliances, but not where they will become wet. Like rodents, most insects are thigmotactic- they like to move with their bodies up against a surface, rather than across the middle of a room, so many sticky traps are placed against walls. Pheromone traps, however, are more effective when placed in air currents (follow the manufacturer's recommendations), but not where they would attract insects from outside.

The number of traps required in a room varies depending on the kinds of objects and pests present and severity and location of infestations. The numbers of traps used should be increased if infestations cannot be found or controlled.

Sticky traps with insects on them are generally replaced with new traps at each regular check and recording of trap contents. In some instances, this does not have to be done if there are only a few small insects on the trap. In this case, a fine tip marker or pen can be used to circle or mark pests on a trap so they will not be counted during the next inspection. Since dermestids were identified as a pest posing a significant threat to museum objects at the park, captured insects must not be left out on traps for prolonged periods. Dermestid larvae are unique among insects in that they can be found on traps eating the bodies of other dead insects without themselves sticking on and dying. While most insects die very shortly after being stuck to a sticky trap, the dermestid larvae can sometimes live for many months, shedding their larval skins, eating other insects, and then escape back into the room (either as a larva or pupated into an adult beetle). It is not unusual to see the frass (looks like ground pepper) or shed larval skins of dermestids on the trap but not the larvae themselves. Adult dermestid beetles sometimes lay their eggs on insects caught in traps and that is where the larvae come from. It is important (after checking and documenting the catch on sticky traps) to not leave out any traps containing dermestid larvae. Traps with large-bodied insects such as flies, large spiders, crickets, ground beetles, etc. should never be left out longer than a month because the dead insects are very likely to attract dermestid larvae.

Light traps and pheromone traps can be considered baited traps and are somewhat more selective of species caught, but are primarily a monitoring tool. Light traps will attract many of the flying museum pests including adult dermestids (carpet beetles, hide beetles, larder beetles), spider beetles, drugstore beetles, powderpost beetles, cigarette beetles, fungus beetles, cluster flies, some grain moths, and more.

Snap traps should be used to monitor for rodent activity and baited traps should be examined daily for dead animals. In locations of infrequent rodent activity, the traps should be baited with yarn tied to the trigger for the mice to use for nesting material. This way, food bait will not attract insects. When mice are known to be present, an aggressive trapping/monitoring program uses two traps placed at each trapping station against walls, in corners, and in other areas of rodent activity. Whenever evidence of rodents is found, more snap trap stations should be set in the area for control as well as monitoring. These can be baited with appealing food bait, such as peanut butter. Trapping should be followed up with any improvements needed for exclusion of rodents. At least one trap station can be located in the collection storage room for general monitoring purposes.

All areas in the monitoring program with sticky traps should be monitored and recorded every month. The traps in the collections storage room can be checked bi-weekly like they were before if the staff has time.

Sources of Moisture Available to Pests
All pests need some water to survive. Before pest management efforts can be effective, all possible sources of moisture which supports museum pests must be located and removed. Inspections should concentrate on finding sources of dampness that may attract microorganisms and fungus-feeding beetles, flies, mites, silverfish, booklice, springtails, and other pests.

Inspections should watch for spilled or condensed water around water coolers and fountains, de-humidifiers and humidifiers, and water pipes. Mechanical rooms, floors, and ceilings should also be checked for water leaks. The maintenance staff should report on the locations where water leaks or pests have been seen.

Inspections should include examinations of the exteriors of buildings that house museum collections to look for possible sources of moisture that could attract pests, such as roof leaks.

Food Available to Pests
Inspection activities in buildings containing museum items should be alert to all possible sources of food available to pests anywhere in the building. This includes candy, sugar, fresh fruit, snacks, etc. stored in office desks and cabinets; empty aluminum cans or food containers destined for recycling; spilled food materials or dirty dishes in snack rooms; and dead insects or rodents on sticky traps. Trash cans should be inspected to see if trash is being removed from the building every night, if the lids of exterior containers fit tightly, and if exterior trash areas are kept clean.

Park policy should prohibit the presence or eating of food and drink in the rooms with museum collections. All food garbage should be removed daily to exterior trash cans.

Importation of Pests
All goods coming into the collection storage or exhibit areas (i.e., museum objects, new acquisitions, supplies, equipment, boxes, wooden pallets, etc.) must first be carefully inspected for possible pests or microorganisms. Establish a quarantine area (Prospector Room?). The inspection should be done with good lighting, magnifying lenses, and should be done on a table with a white surface where any fallen insects, droppings, frass, etc. can be readily noticed. The underside of furniture should be examined for webbing and insect eggs. Wooden objects should be inspected for exit holes of woodboring insects. (See Appendix A to identify woodborers by their exit holes and frass.) Corrugated boxes can sometimes provide harborage for silverfish, cockroaches, or dermestids. Any questionable items should be quarantined for at least several weeks before they enter collection areas by being isolated on white paper in a heavy plastic bag or a box with a sticky trap, and closely inspected again, before integrating into collection storage.

A UV black light can be used in the dark to detect some kinds of mold on objects, and it can also detect rodent urine. The mold and urine fluoresce under black light. (See Appendix E for suppliers).

Inspecting incoming objects with magnifying glass (NPS stock photo)

Spider webbing and eggs under furniture (NPS stock photo)

Collection objects should have a condition report written, through which each object is determined as pest free. *Pest Incident Report* forms (Appendix C) should be filled out when pest evidence is discovered on objects.

Pest evidence should be removed before the goods enter the collection storage or exhibit areas, such as vacuuming off all webbing and spider eggs. Potentially infested items can be treated with a freezer treatment, mechanical cleaning, or other appropriate method before they enter the collection storage or display area. A conservator can be contacted for advice on treatment.

Records

A monitoring system is only as useful as its record keeping system. The IPM inspection and monitoring records must be written and kept in the park's permanent files. Records of long term monitoring activities will serve as a guide for planning future controls.

As part of this Museum Collection IPM Plan, a *Museum IPM Notebook* in a three-ring binder was provided as an effective way to organize these records. The IPM Notebook should be kept for each year, divided into months, and should provide a chronological record of information such as the computer printouts of pest monitoring data, *Pest Incident Reports* for when pests are found on objects, pest identification reports from outside sources, site inspection worksheets, and all records of control actions (dated) such as pesticides, exclusion improvements, intensive housekeeping, freezing, or anoxic treatments on objects. *Freezer Treatment Report* forms are also included in the notebook for recording freezer treatments on objects. Notes should document the timing, techniques, kinds of action taken, and relative effectiveness of control measures. Environmental monitoring reports correlating to the pest monitoring reports can be filed together by month in the *Museum IPM Notebook* if desired.

Material Safety Data Sheets (MSDS) and product labels should be kept on file in the IPM notebook for any pesticides or chemicals used. Copies of *Pesticide Use Proposal* forms and the annual *Pesticide Use Log* should be filed in the IPM Notebook. Permanent IPM files should contain the names and addresses of persons with technical expertise, sources of pest management and chemical pesticide supplies, local pest control operators, state health departments, and other pertinent information applicable to the park IPM program. The IPM plan, PUPs, pesticide labels, and material safety data sheets should be available to all staff members and their location should be well known.

The museum pest monitoring program that was set up for this project has its record-keeping managed on a Microsoft Access database on the park's computers. It is a system that records at least the minimum required information: park name, name of the recorder, specific location in the park, date of observations, pests that were observed, number of pests observed or captured, resource that the pest was observed on, life stage of pest (adult assumed unless recorded in comments), and measure of monitor's perception of damage (in comments).

The monitoring database program has user-friendly screens for entering data on pest catches. There is also a push-button screen that automatically prepares useful reports for any range of dates. The most useful reports are those for "Total Catch" for all organisms monitored for a date range; "Museum Pests" reports only on those pests of most threat to museum collections; and "Single Pest" reports on any individual pest to see the distribution around the site for any range of dates. Print and file reports for "Total Catch" and "Museum Pests" for every month.

It is best if the monitoring is conducted at regular intervals so that numbers and observances can be compared from one monitoring period to the next. This monitoring program was set up with a recommended interval of checking and recording trap catches every month in all collection areas (more often if possible). When insects are left in sticky traps over a month, catches are very likely to attract and support other museum pests such as dermestid larvae, which feed on them.

Prior to the computer database being set up in summer 2009, pest monitoring worksheets were kept, and can be stored in the 2009-2010 *IPM Notebook*.

Environmental Monitoring
It is important to correlate information from environmental monitoring with that of pest monitoring. The museum curator has dataloggers in the collections storage and exhibit rooms to continually monitor indoor climate (temperature and relative humidity). All records from the dataloggers are permanently filed. Relative humidity out of the desired range has been difficult to regulate with the building-wide HVAC system, although portable dehumidifiers could be used. These extremes in RH are important to note because high RH can lead to biodeterioration by attracting insects and microorganisms. There are often microclimates within rooms that can be detected with portable thermo-hygrometers. The park also records data from the National Weather Service, Seattle Office, on a Daily Observations Chart. The museum curator and the IPM coordinator should compare trends in pests, especially moisture-indicating ones (like silverfish, booklice, and springtails) with information from the datalogger records as monitoring continues. Correlations should be recorded in the *IPM Notebook*. Environmental records were not reviewed during the IPM inspection, but an analysis of temperature and RH data is completed at the park at regular intervals. Generally, the range of temperature and RH fluctuates too widely because of the difficulty in maintaining an environment in a large historic structure. The wide swings in temperature and RH in the collections storage room indicate that it is being affected by its proximity to the areaway and outdoor environment.

The moisture content of wood can be monitored to see if woodboring insects are likely to infest or reinfest wood. A wood moisture meter such as a Wagner L606 is suitable for this use. Wood-infesting insects prefer wood with high moisture contents, and will generally reinfest wood with moisture content of over 12%. In the exhibits, the log cabin and boat exhibits and the wood around the stairs were checked and their wood moisture contents were 10% or below.

INJURY AND ACTION THRESHOLDS

A key concept of IPM is the use of injury levels or action thresholds to determine if the pest problem is serious enough to justify some kind of treatment. The **injury level** refers to the point in the growth of the pest population when the numbers of pests are sufficient to cause some unacceptable degree of injury for a specific site. An **action threshold** is the point at which you take action to reduce the pest population. The IPM Coordinator or curator should review and may change or modify action threshold values or preferred control methods to best meet the needs of management objectives for the area.

Injury or action thresholds are criteria used to justify the need for pest management actions and are based on the following monitoring data:

- Estimates of pest population size
- Location of pest problem
- Documented damage to structures or historical or natural resources
- Costs for repair of damage
- Knowledge of pest biology (potentials for population increase and expected damage)

Before initiating chemical pest management actions under this action plan, the park IPM coordinator or superintendent should decide if management actions are necessary because:

- The pests are at a level where they are causing (or will cause) unacceptable resource damage.
- The pests are a human health hazard.
- Without management, pest numbers are expected to continually increase.

***Refer to Appendix A, Action Plans for Pests for guidance on specific action thresholds.**
Museums and curatorial storage areas protect valuable items and, generally, cannot tolerate even incidental numbers of insect or mammal pests. Museum insect pests are secretive and once finding suitable environmental conditions and a source of food, quickly become numerous and may cause irreparable damage to museum objects. Action thresholds, therefore, are much lower in museum areas than they are for pests in other park surroundings. **The action threshold for organisms identified as museum pests** (see pest list, Appendix B) **will be the sighting of one adult or larval insect in the Visitor Center exhibits and the KLSE collection storage areas, curatorial work areas and library.** Although finding shed larval skins and/or feeding damage could be the result of an old infestation, these signs should be regarded as an indication of an active infestation in regularly monitored collections. Shed larval skins and frass should be removed from objects after identification. While not all insects that invade a museum environment are directly damaging to collections, their presence is a nuisance and a food source for other pests. The action threshold for these insects will depend on their proximity to the collections, and whether the collections are protected in an exhibit case or museum storage cabinet.

Action should be taken to eradicate damaging museum pests when direct evidence is identified on an object, such as shed carpet beetle larval skins found on a textile or a pile of frass next to an exit hole in a wooden object.

Action should also be taken if a particular “museum pest” is caught in a sticky trap during two consecutive monitoring periods. This should alert the inspector to increase the vacuuming and inspection schedule of objects that would be damaged by the specific insects and to increase the monitoring frequency of the traps. Review the life cycle and feeding habits of the identified pest and focus efforts on areas in the building that fit those needs. Check the ambient environmental data to spot unusually high humidity that may have triggered new activity. Review pest data from prior years to see if it reflects seasonal activity.

Category I Areas: Action thresholds for general pests are most stringent in **rooms where collections are kept**-- the collections storage room, exhibit rooms, the possible future collection storage room, the library and the library offices. These rooms require monitoring with sticky traps that are checked at least monthly and frequent inspections. Any "museum pests" in these areas will require special attention and management action. "General pests" and "predators" should be managed if possible, especially if their numbers exceed the thresholds in the "Action Plans" in Appendix A, because their bodies or detritus could attract museum pests. The closer the pests are to the artifacts, the more serious the problem is. Live plants, food and drink should be prohibited in these rooms.

Category II Areas: Action Thresholds are slightly less stringent for the **areas adjacent to Category I Areas**, like the other rooms in the basement and first floor, the areaway, offices where museum records are stored, and offices where objects may be researched before they come into the museum collection. The break room is also in this category because of the greater likelihood of pests being attracted to food. Some of these rooms will also be monitored with sticky traps and all should be checked and pest incidents recorded in the "Observation Log' entries in the database. Any "museum pests" in these areas will require special attention and possible management action.

Category III Areas: Category III Areas consist of the **remainder of the Cadillac Hotel building**. These areas still require maintenance and observation, however not to the degree of the category I and II rooms. Occupants of these rooms should know to report any pest observations to the park IPM Coordinator for inclusion in the IPM monitoring database as "Observation Log" entries, and appropriate actions. All areas in the building could potentially be an access point to pests, and the IPM coordinator or curator may decide to add sticky traps or rodent snap traps if additional monitoring could locate the source of an infestation. Rodents will be managed in all areas of the building.

CONTROL ACTIONS

Museum pest management should use all possible physical, mechanical, and cultural pest control methods that consist of sanitation, habitat modification, and monitoring. Treatments to reduce or eradicate pests shall utilize the lowest risk methods.

General Prevention

Prevention is the most effective and least costly management option. The following preventive protocols should be instituted in structures that house collections, exhibits, and curatorial storage areas:

- Holding or quarantine areas should be assigned and those areas should be regularly inspected to ensure infestations do not spread into the building.
- All materials should be thoroughly inspected before being brought into the museum. All material to be brought into the museum space that has a high risk of (or is suspected of) harboring pests should be held in quarantine, incubated, and monitored for a period of time to ensure it is pest free.
- Any material containing evidence of active insect infestation should be sterilized by appropriate means before being accessioned into the museum. Freezing is appropriate for some collection materials following the guidelines given in Conserve O Gram 3/6 (Appendix G).
- All items in the collections with high risk for pest infestations (woolen rugs, taxidermy specimens, hair, fur, feathers, herbarium, etc.) should be regularly inspected (preferably monthly) to monitor the effectiveness of exclusion and management strategies.
- Any materials in museum collections found to show signs of active pest infestations should be immediately removed from display/storage and isolated. An isolation bag or box should be

brought to the object; the infested object should not be carried through the museum before being wrapped. Following removal, the items and area surrounding the infestation should be inspected and treated by appropriate means.

Cultural and Mechanical Controls

Pest control methods which rely on good exclusion, improved sanitation, reductions in harborage available to pests, and continual trapping are generally highly effective and usually eliminate the need for pesticides.

Exclusion

Exclusion is defined as finding and eliminating points of access pests use to enter a structure or room. Entryways may be as small as hairline cracks in walls or as large as gaps under a door, holes around pipe traces, uncapped chimneys, or the complete absence of doors or screens on windows. For most pests, exclusion is even more important and effective than increased sanitation. Pests simply will not be present in a building or cabinet if they do not have an entryway. All possible routes of pest entry or attraction must be found and eliminated. Periodic monitoring will guarantee the prompt discovery and correction of any newly appearing entry points. The inspection guidelines in Appendix C are a reminder of a number of common interior and exterior sites to inspect.

Correcting deficiencies in exclusion is usually done by sealing them (i.e., caulking, carpentry repairs, installation of door sweeps, gaskets, screens, installing filters on air vents and hot air registers.) All holes that could potentially allow for entry of rodents (1/4-inch diameter or larger) into structures or rooms should be identified and appropriately sealed. All cracks and holes in walls, floors, chimneys, around utility lines or pipes, or around or under doors and windows should be caulked to prevent insect entry. Stuf-fit copper mesh (Appendix E) is sometimes suitable to block holes. Air registers and vents should be screened with filters. There are certain windows where it has been noted that insects need to be cleaned from the windowsills frequently. These windows should be caulked or tightened if possible to exclude insects.

In collection storage, the more barrier layers to pests, the better. Stored objects that are not protected in gasketed museum cabinets should be regularly monitored. Sometimes the addition of a plastic bag or box will be another barrier to pests. The addition of additional door sweeps and gasketing the exterior or interior doors is another essential barrier to pests.

Various measures should be taken to ensure that museum pests are not inadvertently imported into buildings in or along with infested products or supplies (i.e., museum items or displays, employee clothing, lumber, books that have been placed on loan, corrugated cardboard boxes, etc.).

Habitat Management and Sanitation

Environmental cleanup and good sanitation reduces food, water, and harborage available to pests. Although no amount of effort will remove *all* the potential resources available to pests, good attention to sanitation will help to reduce a site's "carrying capacity" and ultimately reduce pest numbers and make early detection easier.

Interior Sanitation

Because museum pests can survive and rapidly reproduce in structures, good interior sanitation is especially vital for their control. Many museum pests can go for great lengths of time without feeding at all or find abundant food in lint, fabric fibers, mold, and other uncommon sources.

Following the housekeeping schedules for the exhibit areas, storage areas, and research spaces in the KLSE *Museum Preservation Maintenance Plan* should be a high priority.

Vacuuming is one of the most important museum pest management strategies, in exhibits, furnished rooms, and storage. The vacuum cleaner used by curation at KLSE is a NILFISK canister vacuum with a high efficiency particulate filter (HEPA) and adjustable suction. Vacuuming with a vacuum cleaner with a HEPA filtration system is necessary for museum IPM as it will pick up the very fine dust and particles that insects feed on, insects, insect eggs, and mold spores that other standard vacuums will not pick up, and does not exhaust them back into the room. Also recommended are several micro attachment kits for the vacuum nozzle. Separate attachment brushes and heads should be used for cleaning artifact and structures. The contract janitorial staff should also use HEPA –filtered vacuum cleaners.

For museum pests, careful vacuuming on a regular basis should eliminate many of the adults, larvae, and eggs. The eggs of black carpet beetles are very delicate, and can be broken and killed by activities such as vacuuming and shaking woolen blankets outside. The larvae of dermestids avoid light and move quickly away when disturbed. To prevent re-contamination, vacuum bags that may still contain living pests should be freeze-sterilized or placed in sealed plastic bags and removed from the building for proper disposal.

Another essential sanitation procedure is vacuuming all dead and live insects seen in the buildings on windowsills, by the doors, in spider webs, and in corners. Dead insects are a preferred source of food for the dermestid larvae, and adult beetles often lay their eggs on dead insects as a food source for the larvae that hatch. Cleaning of insects, dust, and debris from ceiling light fixtures is also important.

Dusting with a feather duster is not recommended because it tends to spread dust around. “Dust Bunny” and “Mystic Maids Cleaning Cloths” magnetic wiping cloths and clean cotton diapers are considered good dust cloths. A magnetic wiping cloth or brushing dust into a vacuum cleaner nozzle with a soft brush for objects on open shelving is recommended. A vacuum can be used when dusting cabinet interiors.

The park should maintain written records of where and when rodent debris is found in the observation log section of the computerized monitoring program. Droppings should be vacuumed with the HEPA filtered vacuum, taking precautions for disease such as Hantavirus (see Appendix A).

Ant trails on hard surfaces should promptly be washed (with soap and water if possible) after eliminating ants to remove the pheromone scent they leave behind to guide other ants.

The contracted janitorial staff is responsible for vacuuming the floors and rails in the exhibit areas (“horizontal surfaces only”). The park staff is supposed to clean the exhibits in other ways, but on their 32-item “cleaning list”, the only vacuuming mentioned is on the stairs and that is done once per month. The shared vacuuming duty needs better communication between parties because some essential vacuuming to eliminate pests has been neglected.

Eliminating Food

- Proper refuse and trash disposal and removal from the building is very important, especially when museum collections, library collections, exhibits, or curatorial storage are located in buildings also containing employee lunch rooms, kitchens, offices, and other administrative functions.
- All possible sources of food materials, including potted plants, dirt, and lint should be removed from museum collection, exhibit, library, and curatorial areas. Cracks in the woodwork and furnishings in curatorial storage rooms should be frequently examined for evidence of pests. Wall voids and interiors of suspended ceilings should be inspected regularly for lint, dirt, and other possible sources of food for pests. Attics should be regularly checked for dead insects or animal carcasses. Live flowers should not be brought into the museum collection, exhibit, library, or curatorial areas. (Flowers can attract adult dermestids and carry in mites and booklice.)
- Non-historic fabrics should be dry-cleaned to remove stains (i.e., sweat, food, etc.) that attract pests and to kill any remaining insect larvae and eggs. Woolens should be brushed and cleaned (or dry cleaned) to remove larvae and destroy eggs. Rugs and carpeting should be regularly vacuumed. (Consult a textile conservator for delicate historic textiles and rugs).
- All trash and garbage in museums and curatorial areas and in the break room should be kept in metal or plastic containers with tight-fitting, secure lids. The interiors of trash receptacles should be frequently washed and sterilized. Food trash must be taken out of buildings every night. Recycled containers must be rinsed.
- When employee lunch rooms are located in the same building as museum collections, food spills, dirty dishes, and other sources of food for pests should be promptly cleaned up. Foods in the employee break room or other rooms should be kept in the refrigerator or tightly sealed glass or plastic containers.
- Define whose responsibility it is to clean the kitchen. All staff should clean up their food residues and dishes after using the break room.
- Animal wastes (including rodent feces) should be regularly removed from building interiors and exteriors and properly disposed of.
- Old mold spores should be vacuumed from walls and structures using a HEPA filter vacuum.
- Food consumption or storage should not be allowed in the museum collection, exhibit, and curatorial storage areas. Materials of natural origin such as animal feed, birdseed, and rodent poison should not be stored or made accessible to pests in buildings housing museum collections, exhibit, and curatorial storage areas. Where such materials must be kept in the building, they should only be kept in very tightly sealed containers.

Eliminating Water

- Indoor pests require a source of moisture to be able to survive.
- Plumbing or sewer leaks should be promptly repaired.
- Roof, window, or building leaks should be promptly repaired.
- Cold water pipes should be insulated to prevent the formation of condensation.
- Sub-floor moisture problems should be corrected by increasing ventilation or by placing moisture barriers beneath buildings.
- Keep relative humidity low to reduce infestations of insects such as silverfish that require high RH to thrive.
- Live plants should not be permitted in museum collection storage areas, exhibits, and library. Plants in other areas of the building should be inspected regularly for pests.
- Use dehumidifiers with drains to the outside when environmental monitoring shows that the relative humidity is too high in collections areas (above 65%).

Eliminating Harborage

- Indoor pests also require harborage where they can hide and reproduce. Furnishings and objects in storage and on exhibit not moved or disturbed frequently are attractive homes for pests.
- All clutter and debris should be removed from curatorial areas. The museum and display areas should be thoroughly vacuumed and other rooms and offices in the building should be vacuumed weekly. Museum curatorial storage areas should be thoroughly vacuumed at least once a month and more frequently when possible, to remove accumulated lint, dirt, organic debris, and insects. Vacuuming should include floors and cabinets, walls and windows, in, around, and under equipment, pallets, and furniture, and structural cracks and crevices. Cleaning denies pests food and harborage and reduces insect survival rates.
- Equipment in museum storage areas that have inaccessible spaces where debris or lint can accumulate should be replaced. Boxes and other items often stored on floors should be moved to shelving and cabinets and kept neatly arranged.
- Bird, wasp, and bee nests should be removed promptly from the building exterior and organic debris (feathers, dead insects, animal excrement, leaves, etc.) should be removed from building ledges or gutters. The nests are harborage for dermestids and mites and often support dermestid infestations.
- Rodents and other pests often move into structures from the outside. When exterior conditions support high animal numbers (available harborage and food), pressures are increased for rodents to move into buildings. In buildings that house museum collections, environmental conditions around them that enhance pest numbers should be corrected. All piles of wood, stone, debris, rubble, building materials, trash, and other material near the building should be removed.
- Low spots in the ground that accumulate water run-off should be filled, and other water-holding sources (such as old tires, cans, refuse, and hollow trees) should be eliminated. Eliminate water draining toward building foundations.
- The areas around garbage dumpsters should be kept clean and dumpster or garbage can lids should fit tightly. Garbage should be regularly removed and spills cleaned up immediately.
- Where possible, outside lights should be mounted 30 or more feet from buildings and aimed to shine back onto the building, instead of being mounted on buildings. Where possible and if needed, high-pressure sodium vapor lamps, which attract fewer insects and are more energy efficient, should be used around buildings.

Habitat Modification

- The availability of locations attracting pests or serving as places where they can hide and reproduce is often a regulating factor in the development of pest populations. These sites should be identified during inspections and made unavailable or unattractive to pests.
- Deny birds roosting or nesting opportunities on or against the building. Bird roosts on the building should be eliminated by installing slant board barriers if necessary.
- Indoor humidity and temperature should be regulated in museum and curatorial areas and rooms should be kept as cool and dry (below 55 percent humidity) as practical. The closer that temperatures approach 50º F, the slower insect activity becomes and this lessens feeding and reproduction. Reducing humidity lessens survival of humidity-dependent pests like silverfish (although very low RH is not suitable for many organic objects).
- Inventory records should be maintained so that museum supplies of organic origin should be used on a "first in, first out" basis.
- Where possible, the moisture content of wooden structural elements in buildings should be kept below 15 percent to discourage termite, powderpost beetle, and carpenter ant activity.

Physical Controls

Traps for control

Unlike unbaited sticky traps or "blunder traps" used primarily for monitoring, traps can be baited in an attempt to catch and control pests. The bait can be a food or nesting material as an attractant, a pheromone lure, or a light. **Targeted monitoring using baited traps** over the coming year should indicate if there are other ongoing infestations in selected areas on site:

Light traps should be used to monitor for **dermestid beetles** and **powderpost beetles** in the spring during the adult flight season (April-July). The light traps should be put in any of the areas where monitoring has already shown a concern, (lower level-center of exhibit room and collection storage room) but not where the fluorescent light would shine on light-sensitive objects.

Light traps take advantage of the fact that many beetles, moths, and flies are attracted to light during their adult life stage. There are light traps for the control of flying insects that are recommended for museum use in some applications. The best ones in museum situations employ a fluorescent ultraviolet tube with a fan behind it that draws in the flying insects that are attracted to the light (flies, dermestid beetles, powderpost beetles, drugstore beetles, other beetles some moths, and gnats) and deposit them into a reservoir or plastic bag for disposal. The insects are not destroyed so they can also be counted and identified for monitoring purposes. Brands using this technology are presently unavailable, but there are brands of light trap available that hold the insects on sticky paper (see Suppliers, Appendix E). "Bug Zappers" should not be used in museums.

One or more light traps can be acquired for this IPM program and will be useful, for example, where carpet beetle adults are in their spring flight season. They can also be used in the collection storage room to monitor for dermestid beetles if the light is shielded or faced away from objects. In the dark, it will not light up the entire storage room, but attracts flies and beetles to a specific area to be trapped. The light trap can be left on continuously, or turned on at night. Light traps should be placed where the light is not visible from an exterior door, as they can attract insects in from outdoors. They are effective for most flying insect pests when placed about one to four feet from the floor.

Pheromones are chemicals produced by insects for communication. There are pheromone lures that can be used as bait for specific museum pests known to be around the building, and can be added to hanging or tent-shaped sticky traps. These are primarily used for monitoring, but may also achieve some degree of control. Pheromone lures are species-specific and available for museum pests including webbing clothes moths, black carpet beetles, varied carpet beetles, Trogoderma, and various grain moths and beetles. Most are sex pheromone lures designed to attract flying adult males. Pheromone traps for clothes moths and dermestid beetles can be placed in rooms with textiles during the adults' flight season in the spring to monitor whether these pests are present. New pheromone lures should be added to the traps about every four months, but especially from April through July, the spring flight season of many of these pests. See "Suppliers" in Appendix E.

A silverfish jar trap can be made with a small, straight-sided glass jar. Wrap textured masking tape on the exterior. If desired, the interior can be baited with a dusting of flour on the bottom. Place in areas where silverfish are expected, and they will climb the textured exterior of the jar and fall in and be unable to climb out.

Snap trapping is an effective means for suppressing rodent populations and does not present the problems of animals dying in inaccessible locations. The use of snap traps is the principal method endorsed by the NPS for removing indoor rodent infestations. Effective rodent trapping depends on saturating an area with

a large number of well-maintained traps, using baits that attract rodents, and placing traps where animals will encounter them. Rodents are thigmotactic—they like to travel close to walls and objects where the side of their body is close to a surface, rather than going across the middle of a room. They usually have repetitive pathways. Follow the trapping strategies suggested in *Commensal Rodents: IPM Training Manual*, 1993.

Traps should be adjusted to snap closed with the least amount of disturbance (by filing off manufacturing burs from the trigger mechanisms and careful setting). Two traps should be placed at each trap station and parallel with the wall, or single traps should have their trigger ends against the wall. To control existing infestations, trap stations should be located every 6 to 10 linear feet along walls and runways used by rodents. The better trap locations are behind or under objects, against walls, or in other locations where rodents find concealment. When rodents are known to be present, bait the traps with a mixture of peanut butter and oatmeal, other foods, or cotton balls. A few traps should be kept out continually year-round, just baited with cotton, which is attractive as a nesting material for female rodents. For trapping rodents out-of-doors, place traps at the mouth of rodent burrows and check them at least once a day.

Because of concerns over Hantavirus and other diseases, the CDC, many state health departments, and the National Park Service recommend only using snap type traps (not live-traps or glue boards) to capture rodents. Snap traps prevent the possible spread of Hantavirus into unaffected rodent populations (should captured animals be accidentally released), limit the spread of rodent urine, saliva, and feces around trap sites, protect humans from possible rodent bites, and prevent human contact with contaminated mice during handling and release.

Non-chemical eradication methods for individual collection objects are recommended to eliminate active infestations:

Mechanical cleaning
All objects that have signs of infestation, whether they are active or inactive, need close inspection and cleaning where the insects and their detritus are carefully picked, brushed, and vacuumed off the surfaces. A HEPA filter vacuum is necessary to prevent spread of the infestation. It is important that great care be taken to remove all signs of pests, including eggs. After mechanical cleaning, the objects should be sealed in a clear plastic bag on a white or black paper for 3-6 weeks in isolation from other collections. This allows time where eggs or overlooked larvae or adults can grow and present new signs of activity. Frass or fresh droppings will show against the paper indicating the need for re-cleaning or another pest eradication method.

Freezer treatment
When there is reason to believe that live insects or their eggs are infesting an organic museum object, the infestation can be stopped with a freezer treatment for pest control described in Appendix G, *Conserve O Gram 3/6*. Correctly used, this process will kill all life stages of insects present on or in an object. It will not prevent reinfestation. The process described in *COG 3/6* involves two sessions of at least 48 hours in the freezer with an interval between cycles of 24 hours at room temperature. (After the first freezer cycle, the object is slowly brought up to warm room temperature, kept at room temperature for 24 hours, then immediately put back into the -5 degrees F freezer for a least another 48 hours.) I often recommend that at least one of the cycles in the freezer be extended for a longer period if possible, especially for larger or densely packed materials. This method is suitable to treat objects that are potentially infested with insects including small wooden objects, textiles, rugs, animal skins, taxidermy specimens, paper, archives, books, and small furniture. A conservator can be consulted to help decide if a collection object can be given the freezer process without damage. The object would first be sealed in a polyethylene enclosure and placed

on a rigid support before going into the freezer, and remain in the polyethylene enclosure and on the support for the entire treatment until is a back at room temperature for the second time. This prevents condensation from getting on the object.

The park does not presently have an appropriate chest freezer available on site for pest control treatment of museum objects. However, two appropriate freezers are available for use at Mount Rainier that go down to -80 degrees C. When MORA uses their freezers for pest control, they keep objects in the freezer for seven days, take them out until they reach room temperature for 24 hours, and then put them back in the freezer for seven days. The Burke Museum at the University of Washington also has a freezer that can be used. During the inspection of stored and exhibited objects at KLSE, only several objects were found with pest evidence. The woolen blankets infested with live clothes moth larvae were isolated in a large plastic bag, inspected and then sealed until they were brought to the freezer at MORA for treatment.

The freezer treatment can also be used as a precaution to disinfest potentially infested organic objects before they are transferred to another facility or placed in a collection storage room or cabinet.

Freezer Treatment Record forms (Appendix C) should be filled out to document all freezer treatments on objects. The forms should be filed by date in the *Museum IPM Notebook*, and a copy should be placed with the object's catalog or accession records.

Anoxic treatment
Anoxic atmosphere treatment removes oxygen from the atmosphere causing insect pests to be killed through oxygen deprivation. Anoxic (without oxygen) microenvironments may be used to treat insect-infested museum objects when the objects cannot be put through the freezer treatment. Both treatments are preferable alternatives to fumigation with toxic gasses, which was commonly used on museum objects in the past, but is rarely recommended now. The anoxic method described in Appendix G, *Conserve O Gram 3/9* involves sealing the objects in an oxygen-impermeable barrier film with an oxygen absorber/scavenger to create an anoxic microenvironment where insects cannot survive. This method is effective and cost efficient. Other anoxic treatments involve atmospheres of carbon dioxide, nitrogen, or argon to displace oxygen in a gas impermeable container. These procedures may be too complicated to perform at the park site, but perhaps can be contracted. The freezer treatment has the advantage that it could easily be done at the park, when appropriate.

Chemical Controls

If choosing chemical pesticides as part of your management strategy, you must comply with applicable authorities pertaining to pesticide use, safety, storage, disposal, and reporting. Where pests cannot be managed by using physical, mechanical, and cultural pest control methods that consist of sanitation, habitat modification, and monitoring methods, requests can be made to use the most appropriate and effective pesticides within insect habitation areas. The most low-risk management methods should be used first in IPM, so chemical control is often a last resort.

Any use of pesticides or chemicals to control or repel pests must first be approved through the regional IPM coordinator Erv Gasser on an annual basis, and documented through the Pesticide Use Proposal System (PUPS). All pesticide use within KLSE shall be in accordance with service-wide policy as stated in NPS-77, Natural Resource Management Guidelines, 2006.

All pesticide use by residents, contractors, special use permittees, or other non-NPS personnel in KLSE must also conform to NPS policies and receive Regional Office approval prior to use. Restricted use pesticides may only be applied by a state certified pesticide applicator. If contract pesticide applicators are

hired to apply pesticides, a park staff member (usually the IPM coordinator) should be assigned to accompany the contractor and report on the adequacy of treatment. If pesticides are used around collections, a curatorial staff member should accompany the contractor. Guidelines for safety should be strictly followed.

Staff and visitors should NOT purchase pesticides for use in the park. The IPM Coordinator, after approval from the Regional or Washington office IPM Coordinators, can make a request to the purchasing officer to obtain pesticides or contracts. Any product that has a U.S. EPA registration number must go through the approval process.

Material safety data sheets (MSDS) for each pesticide can be obtained from the manufacturer and shall be readily available to the designated pesticide applicator and staff members. The park should keep one copy of pesticide MSDS where the pesticides are stored and a second copy on file at the park's safety office, and another in the *Museum IPM Notebook* along with the pesticide labels and PUPs.

Pesticide applicators will wear personal protective equipment when applying pesticides as recommended on the container label and on the 10-21-A (pesticide use request) forms.

End of year pesticide use shall be reported as directed in the annual call for reporting from WASO. Anticipated pesticide needs for the current calendar year should be requested through the park IPM coordinator. The KLSE IPM coordinator is responsible for on-line completion of the Pesticide Use Proposal (PUP) at http://nrintra.nps.gov/IPM/.

Pesticides will only be applied in KLSE after receiving the regional IPM coordinator's approval. In emergency situations, pre-approval may be gained by telephone. Immediately following each treatment, the pesticide applicator will document treatment on the Pesticide Use Log; copies of individual logs must be provided to the KLSE IPM coordinator by the end of the calendar year so the park IPM coordinator can input use data into the PUP. Document all pesticide use in the *KLSE IPM Notebook* by date.

Uncontrollable or widespread museum pest or wood-destroying insect infestations may require the services of a professional exterminator to apply pesticides or fumigants. A typical instance of this is a termite infestation in a structure. The use of fumigants to eradicate museum pests is a worst case scenario (and rarely done) and one that must be accompanied with good mechanical and physical exclusion.

The use of rodenticides (i.e., poisoned rat or mouse bait) is not recommended inside NPS structures. This is especially important in buildings with museum property where poisoned rodents dying in inaccessible locations would attract other museum pests like dermestids. The regional IPM coordinator should be contacted for recommendations or approval before rodenticides are used outside buildings.

Before using any pesticide to control pests, it is important to be able to identify the pest and know its harborage areas so treatments can be placed in the most effective locations. However, pesticides can never be regarded as a substitute for good prevention and sanitation practices. Using pesticides in a museum environment without removing and sterilizing the infested materials will never fully control infestations. Attempting to suppress insect populations with pesticides without making accompanying changes in the environmental conditions supporting those pests only gives a false sense of security and further encourages development of chemical resistance in pest populations. Pesticides should never be used as the sole or principal method of pest management. Persistent pesticides may leave residuals on objects and can damage them. In most cases, only non-persistent, short-residual pesticides with relatively lower toxicity should be used; products used should be labeled for use in public buildings and

institutional settings. An exception to this would be when low toxicity residual dusts are used as crack-and-crevice treatments or in inaccessible voids in buildings.

Low toxicity residual dusts are sometimes approved for use as crack-and-crevice treatments in museum environments. Insecticide-grade boric acid, diatomaceous earth, and silica aerogel dusts and sprays are effective chemical pesticides having long residual action and can be applied deep into pest harborage with a narrow diameter nozzle and a bulb duster. Only a thin dusting of these dusts is needed. These all remain active in cracks and crevices unless they get wet. They act to desiccate and kill insects by abrading their exoskeletons. Boric acid also acts as a stomach poison to insects, but is non-toxic to mammals and birds.

Boric acid dust is often used under furniture and in drawers, cabinets, voids, sinks, and around pipes. Insects that crawl across it ingest the chemical when cleaning their legs. Boric acid dust, like all pesticides, is harmful to breathe and a dust mask, goggles, and gloves should be worn during application. Although boric acid may take 7 to 14 days to kill insects, it remains active in cracks for a very long time. Although insects may develop resistance to many other pesticides, no insect resistance to boric acid has yet been shown. After applying boric acid into cracks and crevices, it is best to seal the cracks with caulking to keep those areas from being used as future harborage and to prevent moisture contamination.

Do not use pesticides on museum objects. Any potential plan to do so must be discussed with a conservator. Many years ago, when pesticide use on museum objects was a widespread practice, many specimens were irreparably contaminated (with pesticides like arsenic, mercuric chloride, cyanide, naphthalene, paradichlorobenzene, etc.) so the objects were hazardous to staff and museum visitors who came in contact with them. In addition, many museum materials themselves were permanently damaged by the chemical pesticides used (e.g., corrosion, dye and color changes, melting, increased acidity, chemical changes, and embrittlement).

An exception to the ban on pesticides on objects is sometimes made for large wooden objects. Some wooden artifacts or structures that are seriously infested with wood-boring insects or fungal decay may be treated with the pesticides Bora-Care or Timbor. An object conservator or historic architect, the park curator, and the park and regional IPM coordinator should be consulted before this option is done. Unlike freezing, treatment with Bora-Care will provide long-term residual protection to the wood against insect pests and fungal decay. These liquids are sprayed or brushed on unfinished wood, and/or injected into insect exit holes.

Over-the-counter unrestricted products are **not recommended** for use. Space fumigants such as mothballs, paradichlorobenzene, naphthalene, and dichlorvos resin strips (No-Pest Strips) are widely available, but not recommended for use in a museum environment due to their damaging and disfiguring effects to a variety of object materials and the potential chronic health effects. They are cumulative poisons to humans. The NPS no longer approves of the use of these space fumigants in exhibit cases or museum storage cabinets.

Various types of solid, semi-solid, and liquid insect bait stations are possible choices for use in museums because they pose low risk to museum collections. Many of these baits contain relatively less toxic chemicals (like boric acid [see Niban] and hydramethylnon) and are attractive to insects because they are formulated with sugar or protein. Normally, about 10 or more bait stations should be placed in each 100 square feet of space and in insect harborage areas. Some bait stations have sticky tape on the back and can be applied to vertical surfaces. However, if sanitation is poor in a building, bait performance will also be poor because insects have alternative sources of foods. Insect growth regulators (IGR's, Gentrol) and repellent chemicals may be another alternative for museum use.

POST-TREATMENT MONITORING AND EVALUATIONS

Pest populations should be continually monitored to evaluate the success of the eradication methodology. Park management should continually track the on-going effectiveness of pest management actions by comparing year-to-year and month-to-month monitoring records. The most important evaluation of a successful pest control program is by comparing post-treatment monitoring results with pre-treatment monitoring results. This information evaluates the effectiveness of specific treatments, cost-benefit ratios, and guides future pest management measures. Post-treatment monitoring should be done immediately following control treatments and then every six months. This information should be shared with the staff and the facility manager.

The ongoing monitoring program includes an opportunity to raise staff awareness about pests and their risks to cultural collections, and get everyone involved in the IPM process. Education and communication are critical to the success of an IPM program. IPM policies can only be implemented through physical and operational changes. Staff and volunteers need to know how they can help minimize pest problems.

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http://tncweeds.ucdavis.edu/

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http://www.ipmcenters.org/IPMRoadMap.pdf
http://www.e-bug.net
http://www.pestweb.com/productinfo/index.cfm
http://palimpsest.stanford.edu/bytopic/pest

APPENDICES

A. Action Plans for Pests
Hantavirus

B. Trap Locations for Pest Monitoring
Initial Pest Monitoring Reports

C. Documentation Forms:
Museum Inspection Sheet; Pest Incident Reports;
Freezer Treatment Reports; Other Documentation

D. Pesticide Labels, MSDS

E. Suppliers

F. Pesticide Use Approvals, Pesticide Use Logs

G. An Insect Pest Control Procedure: The Freezing Process - COG 3/6
Monitoring Insect Pests with Sticky Traps - COG 3/7
Insect Light Traps- PCT
Anoxic Microenvironments: A Treatment for Pest Control COG 3/9
Identifying Museum Insect Pest Damage – COG 3/11

H. IPM Guidelines for Facility Design and Construction

I. Museum Preservation Maintenance Plan Task checklists
(Previous) Museum Pest Monitoring Record forms

APPENDIX A

ACTION PLANS FOR PESTS

HANTAVIRUS

APPENDIX B

PEST MONITORING DATABASE

TRAP LOCATIONS FOR PEST MONITORING

INITIAL PEST MONITORING REPORTS

APPENDIX C

DOCUMENTATION FORMS

PEST INCIDENT REPORT

Park: _____ Catalog #: _____ Date: _____

Object: _____ Examiner: _____

Object location: _____

Materials affected: _____

PEST OBSERVATION

Number of pests observed: _____ Living _____Dead
Identification source: _____

_____powderpost beetle _____drugstore beetle _____spider
_____termite _____clothes moth _____fly
_____dermestid beetle _____silverfish _____undetermined
_____cigarette beetle _____cockroach _____booklouse
_____fungus _____mouse _____other:_____

EVIDENCE OBSERVATION

_____losses _____specks _____egg casing _____ pupal casings
_____holes/tunnels _____webbing _____live insect _____staining
_____droppings _____cast skins _____carcasses _____cast larval skins
_____frass _____ odor _____other: _____

MANAGEMENT ACTION TAKEN

_____ mechanical cleaning: _____
_____ freezing (list duration and dates): _____
_____ fumigation (list fumigant): _____
_____ pesticide: _____
_____ isolation (list method): _____
_____ object requires follow-up inspection (list frequency): _____

ADDITIONAL COMMENTS

_____
_____
_____
_____
_____

FREEZER TREATMENT RECORD

Park: _____ Cat. #: _____

Object: _____

Person(s) in Charge: _____

Freezer used:
MORA freezer _____
Burke Museum freezer _____
KLSE chest freezer _____
Other: _____

Procedural details:
1.
Date in: _____ Time: _____ Temperature: _____

Date out: _____ Time: _____ Removed to temp: _____
(Total hours in:_____ Total hours out between cycles:_____)

2.
Date in: _____ Time: _____ Temperature: _____

Date out: _____ Time: _____ Removed to temp: _____
(Total hours in:_____ Total hours out between cycles:_____)

Rate of thawing manipulated? _____

Pest Incident Report completed? _____

Cleaning/Conservation done to object: Before freezing? _____
After freezing? _____

COMMENTS:
_____
_____
_____
_____
_____
_____

APPENDIX D

PESTICIDE LABELS, MSDS

APPENDIX E

SUPPLIERS

INSECT STICKY TRAPS:

Summit Chemical Company
7657 Canton Center Drive
Baltimore, MD 21224
410-282-5200

"Catchmaster 288I" comes in boxes of 72 (each can break down to 3 units, scented)

Bell Laboratories
Forshaw Distributing Company
2214 Tomlynn St.
Richmond, VA 23230
804-355-1900

Supplies "Trapper Monitors" in boxes of 100 (each breaks down to 3 units)
Supplies "Catchmaster 288I" 4 boxes of 100
Supplies Victors Roach traps in boxes of 150 (each breaks down to 2 units, scented)

Museum Services Corp.
4216 Howard Ave.
Kensington, MD 20895
301-564-1225

Recon traps

Insects Limited, Inc.
10540 Jessup Blvd.
Indianapolis, IN 46280-1451
800-992-1991 or 317-846-9799
http://www.insectslimited.com

Pheromone lures and various hanging sticky traps

UV BLACK LIGHT:

Used to detect rodent urine and certain molds, which fluoresce under black light.
Spectroline UV-4B
www.spectroline.com

SUPPLIER AND CONSULTANTS FOR BORA-CARE:

PRG- Preservation Resource Group, Inc.

P.O. Box 1768
Rockville, MD 20849-1768
Technical Support- Bryan Blundell (301) 309-2222
Fax- (301) 279-7885

BAT CONSERVATION INTERNATIONAL:

Bat Conservation International
P.O. Box 162603
Austin, TX 78716

Shipping Address
Bat Conservation International
500 N. Capital of Texas Hwy.
Bldg. 1, Suite 200
Austin, TX 78746
Phone: (512) 327-9721
Fax: (512) 327-9724
Catalogue Orders and Inquiries: 1-800-538-BATS (2287)

Lost/Injured Bat or Unwanted Bats in your Building?	french@batcon.org
Web or Internet problems	webmaster@batcon.org
General Bat Info	batinfo@batcon.org
Bat House Research Project **	bathouses@batcon.org
Catalogue Correspondence	catalog@batcon.org
Membership Status and Address Changes	members@batcon.org
Photo Usage and Rights Information	photolibrary@batcon.org

St Metro Screenworks
4111 S. Natches Ct. #A
Englewood, CO 80110 USA
Local: 303-922-8998
Toll Free: 800-413-2579
Fax: 303-922-8187 http://www.metroscreenworks.com/shop/contact_us.html

Details

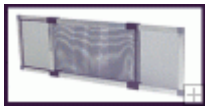
METRO SCREENWORKS Factory Direct Store

Adjustable Window Screens

Our Adjustable Window Screen is easy to install in seconds and without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung windows. The screen has a 5/16 inch (7.9 millimeter) mill finish frame with gray square cut corners, charcoal fiberglass screen wire, and black retainer spline. The adjustable screen unit comes completely assembled, so all you need do is place the screen in the window opening and easily adjust it to the necessary width.
Various screen sizes are available.

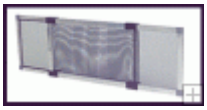
10 Inches High x 19 to 37 Wide Adjustable Window Screen

10 Inch Adjustable Window Screens This unit is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung windows. The screen has a 5/16 inch white finish frame with white square cut corners, charcoal fiberglass screen wire, and black retainer spline. The screen has a width adjustment of 20 to 37 inches. The unit comes completely assembled, so all you need do is place in the window opening and



13 Inches High x 17 to 33 Width Adjustable Window Screen

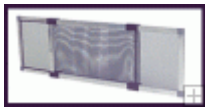
This Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double...
$21.00
... more info



15 Inches High x 19 to 37 Width Adjustable Window Screen

This Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double...
$23.00
... more info

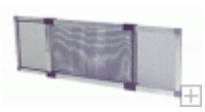
adjust the width. $20.00



18 Inches High x 25 to 48 Width Adjustable Window Screen

This Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung windows. The screen has a 5/16 inch white finish frame with white square cut corners, charcoal fiberglass screen wire, and black retainer spline. The screen has a width adjustment of 20 to 37 inches. The unit comes completely assembled, so all you need do is place in the window opening and adjust the width.

$24.00



18 Inches High x 31 to 59 Width White Adjustable Window Screen

This Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double...

$28.00

Add: 0

Add to Cart

Featured Products - Adjustable Screens

http://www.qualitywindowscreen.com/store/

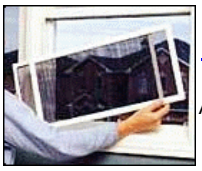
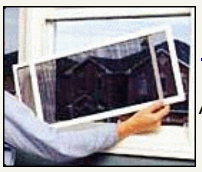
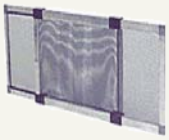
Quality Screen Co. LLC

Window Screens & Solar Screen Supplies

Adjustable Window Screens

Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung windows. The screen has a 5/16 inch mill finish frame with gray square cut corners, charcoal fiberglass screen wire, and black retainer spline. The screen width is adjustable. The unit comes completely assembled, so all you need do is place in the window opening and adjust the width.

Displaying **1** to **4** (of **4** products)

Product Image	Item Name-	Price
	**White Adjustable Window Screen 10" Tall (20" to 37" Wide)** Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung...	~~$15.49~~ Sale: $14.72 Save: 5% Add: 0
	**White Adjustable Window Screen 15" Tall (20" to 37" Wide)** Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung...	~~$18.95~~ Sale: $18.00 Save: 5% Add: 0
	**White Adjustable Window Screen 18" Tall (20" to 37" Wide)** Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung...	~~$21.95~~ Sale: $20.85 Save: 5% Add: 0
	**Adjustable Window Screen 20" Tall (25" to 48" Wide)** Adjustable Window Screen is easy to install in seconds without the need of tools or fasteners. It can be used in wood, metal or vinyl double hung...	~~$26.95~~ Sale: $25.60 Save: 5% Add: 0

Displaying **1** to **4** (of **4** products)

SOURCES OF PEST CONTROL SUPPLIES AND EQUIPMENT

The following list of pest control equipment and chemical suppliers is not meant to completely cover the entire field and is offered as an assistance in finding specific products. Space limitations do not permit including every possible vendor. Undoubtedly, the list omits some products or companies that did not come to our attention. Products or companies listed here are not endorsed or recommended by the United States Government. No discrimination is intended against products or companies not listed. Additional listings classified by subject are found in: Scott E. Hygnstrom, Robert M. Timm, and Gary E. Larson, 1994; Prevention and Control of Wildlife Damage, Coop. Exten. Div., Inst. Agric. and Nat. Res., University of Nebraska, Lincoln NE.

ALPHABETIZED LISTING

http://www.pestweb.com/productinfo/index.cfm

ACR Systems Incorporated, Building 210- 12960 84 Ave, Surrey, British Columbia V3W 1K7 Canada. 800-663-7845 www.acrsystems.com Dataloggers, temperature and humidity

Bird Busters, 1083 Thomas Jefferson St., N.W., Washington, DC 20007; 202/338-6263 Tensioned wire bird repellent system, architectural bird nets

Bird Gard, 800/555-9634, 201/666-8334 Electronic bird repellers; large (5 X 5 X 6 ft.), v-top sparrow and starling live traps.

Bird-X, 730 W. Lake St., Chicago, IL 60661; 312/648-2191 Plastic bird netting, Irri-Tape reflective mylar.

Document Reprocessors of New York, 5611 Water Street, Middlesex, NY 14507, Eric Lundquist or Quentin Schwartz, (800) 437-9464; (585) 554-4500, FAX (716)554-4114 Freezer Unit/ Vacuum Chamber

Industrial Safety Co., 1390 Neubrecht Rd., Lima OH 45801; 800/537-9721 Respirators and replacement cartridges, safety supplies

INSECT IDENTIFICATION SOURCES: **call/write to inquire about services or other sources of identification.**

American Entomological Inst., 5950 Warren Rd., Ann Arbor, Michigan 48105 General insect identification.

Arizona Dept of Health Services, Disease Control, 3008 N. 3rd Ave., Room 201, Phoenix, AZ 85012 Pests of public health concern

Combined Scientific Supplies, P.O. Box 1446, Fort Davis, Texas 79734; 915/426-3851.

Consulting Diagnostic Service, 992 Santa Barbara Rd., Berkeley, CA 94707; 415/642-4950 (days),415/524-9476 (evenings)

Duke University Medical Center, Mycology Center, Div. Infectious Diseases and International Health, Duke Univ., Durham, NC 27710; 919/684-3717 Tests for Histoplasmosis in guano/feces

Fumigation Service and Supply, 10540 Jessup Blvd., PO Box 40641, Indianapolis, IN 46280-1451; 317/846-5444

Okumura Biological Institute, 6669 14th Street, Sacramento, CA 95831; 916/421-8963 Stored products pests

US Dept of Agriculture, Agricultural Resource Service, Insect & Mite Identification Service, The Systematic Entomology Laboratory (SEL); http://www.ars.usda.gov/Main/docs.htm?docid=9353

US Dept of Agriculture, Forest Pest Management Laboratory, 2323 E. Grennlaw Lane, Flagstaff ,AZ 86004-1890; 602/556-7400 Forest disease organisms

Insects Limited, 10540 Jessup Blvd., PO Box 40641, Indianapolis, IN 46280-1451; 317/846-5444, 800/992-1991 Insect pheromones and pheromone trap kits (warehouse, flour, sawtoothed, grain, drugstore, and cigarette beetles; clothing moths; German cockroach); museum pest monitoring kits; pheromones monitoring and software programs

J.T. Eaton and Company, 1393 East Highland Rd., Twinsburg, OH 44087; 800/321-3421. Rodent traps, sticky traps, rodenticides, bait boxes, diatomaceous earth.

Lab Safety Supply, P.O. Box 1368, Janesville, WI 54547-1368; 800/356-0783 HEPA filters, respirators, vacuum cleaners, disposable coveralls

Meile, Inc. 9 Independence Way, Princeton, NJ 08540 www.miele.com HEPA vacuum, adjustable speed

Miracle Marketing Manufacturing Corp., P.O. Box 520125, Salt Lake City UT 84152; 800/634-6102 Li'l Hummer backpack vacuum system (HEPA filters to 0.3 microns), electronic equipment kits, germ filters

Micro-Gen Equipment, 800/777-8570 Innovative fly and insect control systems

Moldex-Metric Inc., Safety Products Div., 4671 Leahy St., Culver City, CA 90232; 800/421-0668 Disposable fume, dust, mist, HEPA respirators; fit testing kits

National Animal Damage Association, NADCA, Rte. 1, Box 37, Shell Lake, WI 5487 National association of wildlife damage management professionals

National Animal Damage Control Association, 800/828-6474 Animal control, public health, and wildlife officials training

Necessary Trading Co., 422 Salem Ave., New Castle, VA 24127, 703/864-5103 Soil care, plant care, equipment, pest management, animal care, information, organic pesticides, bird netting, Tanglefoot (sticky paste), traps, pheromones, predatory insects, other products

Neutron Industries, Formula NI-712 Super Concentrated Organic Odor Eliminator; 800/421-8481.

Nilfisk of America, 300 Technology Drive, Malvern, PA 19355, 213/647-4620 HEPA filter vacuum cleaners with variable suction for museum use

Nisus Corp, Cherokee Place, 101 Concord St. N.; Knoxville, TN 37919; 615/637-1226, 800/264-0870 Bora-Care, borate wood treatment products, Niban-FG boric acid ant bait

Nixalite of America Inc, 1025 16th Ave, East Moline, IL 61224, 309/755-8771 "Porcupine wire" mechanical bird repeller

Paraclipse, Inc., 2271 29th Ave. East, P.O. Box 686, Columbus NE 68602; 402/563-3625 Decorative light traps for flying insects

Phillips Petroleum Co., Bartlesville, OK 74004 R-55 (tert-butyl selfenyldimethyldithiocarbamate) pocket gopher, burrowing animal repellent; for use in soil and on cables; phytotoxic

Phoenix Agritech, P.O. Box 10, Truro, Nova Scotia, Canada B2N 5B6; 902/662-2444, 800/353-9468 Flexinet, netting, posts, chargers to exclude pests

PRG- Preservation Resource Group, Inc. ,P.O. Box 1768, Rockville, MD 20849-1768, Technical Support- Bryan Blundell (301) 309-2222, Fax- (301) 279-7885 Supplier and technical consultant for Bora-Care

Professional Equipment, 130 Dale St., West Babylon, NY 11704; 800/334-9291 Full line of test equipment, moisture meters

Pocatello Supply Depot (PSD), USDA-APHIS Animal Damage Control; U.S. Fish and Wildlife Service, 238 E. Dillon St., Pocatello, ID 83201; 208/236-6920 Gas cartridges for gopher, ground squirrel, coyote, and skunk control; neutroleum alpha and Ecosorb deodorants; Fatty Acid Scent (FAS) and Synthetic Monkey Pheromone animal lures; electronic animal guard frightening device

Racal Health and Safety, 7305 Executive Way, Frederick, MD 21701-8368; 301/695-8200, 800/682-9500 Delta 3 HEPA Filter

R.E. Chapin Mfg Works Inc., 700 Ellicott St., Batavia, NY 14021-0549; 800/444-3140 Hand dusters for application of pesticide dusts

Sandoz Agro, Inc., 1300 East Touhy Ave., Des Plaines, IL 60018 Gentrol Point Source aerosol cockroach growth regulator: pesticides

Sealeze Corp., 8000 White Pine Rd., Richmond, VA 23237; 800/446-6544 Therm-L-Brush door sweeps and garage door seals

Summit Chemical Company, 235 South Kresson St., Baltimore, MD 21224. 800-227-8664. www.summitchemical.com Pest traps

Survival Air Systems (SAS) Co., 3401 69th St., Long Beach, CA 90805; 800/262-0200 Respirators, personal protective equipment

Termi-barrier (Doug Carver), Live Oak Structural, Berkeley, CA 510/524-7101 Sand barriers to prevent termite invasion

Termitect II, PO Box 8301, Albuquerque, NM 87198; 505/263-3703; 505/268-7739 Odor Detector to inspect for termites

Tramex, 1893 Coyote Cir., Golden, CO 80403, 303/582-3538 Non-destructive moisture meter

U.S. Borax, 26877 Tourney Rd., Valencia, CA 91355, 800/984-6267, 231/251-5630 Timbor borate wood preservative

UVEX Safety, LLC, 10 Thurber Blvd., Smithfield, RI 02917; 401/232-1200, 800/343-3411 HEPA-Tech 3010 Filter

Van Waters and Rogers, 2600 Campus Dr., Box 5932, San Mateo, CA 94403, nation-wide number 800/888-4897; Full line of chemicals, pest control equipment and supplies

Whitmire Mico-Gen Research Laboratories, 3568 Tree Court Ind. Blvd., St. Louis, MO 63122; 800/325-3668 Aerosol pesticides, flushing agents, caulking, light traps for fleas

Wilco Distributors, 1215 W. Laurel Ave., Box 291, Lompoc, CA 93436; 805/735-2476 General pest control supplies

Wildlife Control Technology Inc., 2501 N. Sunnyside Ave. #103, Fresno, CA 93727; 209/294-0262, 800/235-0262 Fencing materials, Bat Kit with instructions; seminars in pest control, professional trade magazine

Wildlife Management Supplies, Critter Control Inc., 640 Starkweather Rd., Plymouth, MI 48170; 800/451-6544 Chimney covers, skunk deodorants

Williams Trapping Supply, 4647 E. Station Rd., Roanoke, IN 46783; 219/672-3721 Animal lures, trapping

supplies

Woodstream Corp., Lititz, PA 17543, 717/626-2125 Victor Gopher Getter and Victor Gopher Trap; Havahart live traps; cockroach pheromone sticky traps; light traps for fleas

Zoecon Industries, Professional Pest Management Div., 12200 Denton Drive, Dallas, Texas 75234, 214/243-2321, 800/527-0512 Produces insect growth regulators (IGR's)

APPENDIX F

PESTICIDE USE APPROVALS

PESTICIDE USE LOGS

APPENDIX G

MOLD: PREVENTION OF GROWTH IN MUSEUM COLLECTIONS- COG 3/4

AN INSECT PEST CONTROL PROCEDURE: THE FREEZING PROCESS - COG 3/6

MONITORING INSECT PESTS WITH STICKY TRAPS - COG 3/7

INSECT LIGHT TRAPS- PCT

CONTROLLING INSECT PESTS: ALTERNATIVES TO PESTICIDES- COG 3/8

ANOXIC MICROENVIRONMENTS: A TREATMENT FOR PEST CONTROL- COG 3/9

IDENTIFYING MUSEUM INSECT PEST DAMAGE- COG 3/11

APPENDIX H

Integrated Pest Management Guidelines for Facility Design and Construction

Author: Chris Furqueron
Updated: 2006

IPM GUIDELINES FOR FACILITY DESIGN AND CONSTRUCTION

Construction: Keep construction site clean of scrap wood and other organic materials and allow no wood or organic materials to be buried on site or be incorporated into building fill as these would attract and support termite infestations.

Quarantine: The storage space should have an area to quarantine and inspect incoming collections and materials. Ideally, these areas should be in separate structures. If the quarantine area must be located within the same facility that houses the stored collections, the two areas should not be located adjacent to each other or share a common wall.

Receiving/Unloading Areas: Locate these areas away from collections. Unpack material or objects from their shipping containers before bringing into storage areas. The object may be pest free but the shipping material and container is likely to have come from and area that instituted no forms of pest control and to have sat in a post office or shipping facility among containers infested with roaches and other pests.

Doors: All exterior doors and doors to storage areas should open outward from the building or room, be properly sealed and gasketed to form an airtight seal, fitted with sweeps, and be self closing. A gap greater than 0.25 inches will allow mice to enter the building or room. Storage room doors should not be used frequently to exit/enter the structure or other areas of a building; these doors should remain closed.

Flooring: Should form a continuous, seamless surface, such as concrete or vinyl sheet flooring and extend 4 to 6 inches up walls. Where vinyl flooring is installed on concrete slab or grade, a vapor barrier membrane under the concrete slab and special adhesives should be used to prevent the floor covering from separating from the slab. Otherwise, this creates a place where dust and debris collect and an ideal insect habitat. Cracks and joints create areas where dust and debris accumulate which provide food and harborage for some insect pests. Storage rooms can have no floor drains as they provide entry points for rodents and insects. If a fire control sprinkler system is installed in storage areas, or the room could possibly flood, fit floor drains with backwater preventer valves. It is best if the floor is above grade.

Ceilings: Ceilings can be painted white and left exposed. If ceilings structures are to be covered, it is important that insect hiding places or rodent travel routes are not created that would be difficult to gain access to, collect dust, and treat with pesticides if ever required. Avoid installing drop ceilings.

Walls: Should have seamless surfaces and no cracks that could harbor or allow insects to enter. Paint the surfaces white or a neutral color so that pests can easily be seen. Use a high quality water-based acrylic paint (which do not outgas like latex-based paints) with a gloss finish that contains a mildewcide; this would probably be an exterior grade paint as interior paints generally do not contain mildewcides, however one can be added.

Wall voids should be treated during construction, with a long lasting silica aerogel (e.g. DRIONE, Tri-Die) or boric acid. This will provide long lasting pest control of roaches, silverfish, and other pest insects.

Windows: All windows should be eliminated from storage rooms so as to exclude light, dust, and pest entry. Windows that remain should be sealed off from inside the structure or at the least, closed and sealed tightly. Fit windows that will be opened with 20-mesh screens (most screens are 16-mesh that permits carpet beetles to enter). Adult carpet and odd beetles will congregate on windowsills as they try to leave the building; monitor these areas for indications of an infestation.

HVAC and Air Intake Vents: Consider using filters (HEPA) that are capable of filtering out smaller particles such as pollens. These are available through medical suppliers that specialize in allergy control.

For storage and archives, consider using a closed system. Screen intake vents from storage or quarantine areas. Future maintenance of HVAC duct systems and lowering the risk of disasters is critical at the design stage. Consider the relationship of HVAC and emergency preparedness (especially with regard to ventilation) and design for prevention (e.g. use unlined metal ducts rather than fiberglass lined to limit air pollutants). Normally well-designed air distribution systems will prevent mold and bacteria growth, but operational failure can spell disaster. Single zone systems are the easiest; components consist of air supply, filters, supply conditioning mechanism(s), distribution, dampers and returns, and exhaust. Consider both the entry point for replacement air and return duct paths. Choose locations to limit contamination from interior and exterior sources.

Air conditioners: Window units should be tightly sealed. Pigeons and other birds may nest under AC units and create problems. Bird mites can enter a room through poorly sealed units. Dermestid beetles feeding on feathers in the nest may relocate inside and attack natural history specimens. Insects that enter a museum and then die serve as a ready food source and reservoir for carpet beetles, cigarette beetles, and other museum pests.

Utilities: All openings where utilities (gas lines, water, electricity, telephone, TV cable, air conditioners, etc.) enter the building and rooms must be tightly sealed with concrete or wire to render rodent proof and silicon (or similar product) to render insect proof. This is especially important where wiring in the attic enters overhead lighting fixtures. This also includes entrances from all interior penetrations such as restrooms and areas that share common walls with collections.

Pipes and Ductwork: Eliminate from storage rooms. These can be a source of leaks and condensation that may create habitat for certain species, besides the possible physical damage to collections.

Plumbing: The detection and repair of water leaks is critical. Restroom and kitchen plumbing should be caulked where pipes and drains enter the walls and floors. Pull back escutcheons and inspect pipe/wall junctions.

Lighting: Avoid using recessed lighting in storage areas. This type of lighting attracts and traps insects that have overwintered in attic areas. These insects are then food sources for dermestid beetles. Ceiling lighting in storage areas can be hung or surface mounted. Lighting must be adequately bright enough to inspect for pest evidence, but should be turned off when no staff is present. Sodium vapor lights of low wattage can be placed near exterior entrances (better yet, away from entrances, but never above an entrance). The higher wattage mercury vapor lights and incandescent lights should be placed off and away from the building and entrances so that the light shines toward the entrance. This lighting positioning will draw insects away from the building. Electric fly grids should not be used outside a structure; they can be very effective when placed inside structures where insects are likely to enter or be a problem (e.g., loading and storage areas) but should not be placed in locations that are visible from outdoors.

Garbage disposal: The dumpster/compactors should be rodent proof (no openings or gaps greater than 0.25 inches). Install drain plugs in the dumpster to prevent rodent entry. Lids should also be tight fitting to form a secure seal. Dumpsters should be placed on concrete pads or better elevated off the ground so that inspections for pests and moisture can be made.

Exterior Walls: Ideal surfaces would be those such as brick, block, or stucco that are seamless. Otherwise, seal all cracks with silicone, thus offering no pest or water entry points. Seal around windows, eaves, etc., and screen weep holes and wall vents.

Eaves and Ledges: Eliminate exposed beams or rafters if possible to discourage bird perches and nest sites, and eliminating eaves will reduce insect (wasp) nesting. Horizontal ledges and other possible nesting and roosting sites can be rendered bird-proof by retrofitting with 45-degree slopes.

Landscaping: Grade the soil so that water drains away from the structure. Minimize harborage for insects, rodents, and birds outside the structure by removing vines and other plants growing on the structure. Trim branches from nearby trees so that they do not touch or extend over a structure; this reduces debris accumulation in the gutters, reduces wall dampness, and eliminates entrance avenues for pests. It is preferable to remove plantings from foundations and walls. An alternative to their removal is to move the plantings at least 4 feet away from the structure and to install a 3-foot wide, 2 to 4-inch deep gravel strip around the perimeter of the structure to prohibit vegetation from growing around the foot of the structure. Direct irrigation away from the foundation and exterior walls or if absolutely necessary, install drip irrigation or soaker hoses. If shrubbery is planted, select low growing non-flowering species (adult dermestids feed on pollen). If mulches are necessary, use stone or cypress that is less attractive to insects and resists decay. Mulch should not exceed two inches in depth. Prohibit all live plants and cut flowers within the structure.

Roof Drains and Downspouts: Size adequately to handle rainfall and place so that drainage removes debris accumulations, permits no standing water, and transports water at least 10 feet away from the structure. Typically, small, but more closely spaced drains are preferable to fewer, but larger drains.

General Ideas:

- Caulking to close cracks is especially important. Some points were listed above. Diligent attention to caulking should be made around window and door frames, where walls join at corners and meet the foundation, and around vents, ductwork, pipes, electrical conduits that penetrate walls.
- Incorporate a vestibule into the building design. These areas don't have to be heated or cooled and function as an air lock, reduce the exchange of conditioned air, and create another pest barrier.
- Install all shelving and cabinets at least four to six inches off floor. This aids cleaning, pest control, and lessens damage if flooding occurs.
- Use rounded joint and corners to minimize dust and rounded joints between floors and walls to facilitate cleaning.
- Isolate food handling (kitchen/lounge) areas away from collections and provide direct access outside so that garbage can be taken directly to the dumpster and not hauled through the facility. It is best to restrict food to no more than one room. Install self-closing doors to these areas from both inside and outside the structure.
- Trash, especially from the kitchen and break rooms, should be removed at the end of the day and not left overnight in the facility.
- Furniture from the museum collection can be stored on shelving platforms lined with white paper so that any insect bodies, frass, etc. will more readily be seen.
- Pre-treat with termiticides below concrete slabs and around the foundation for termites.
- Obtain blueprints or (better) as-built designs (from architect or engineering firm).

Information Sources

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APPENDIX I

MUSEUM PRESERVATION MAINTENANCE PLAN CHECKLISTS

(PREVIOUS) MUSEUM PEST MONITORING RECORD FORMS