

Managing pests in the collection: Integrated Pest Management (IPM)

This Help Sheet relates to standard C2.1

This help sheet has been adapted from a workshop on Integrated Pest Management prepared by Artlab Australia in 2010

We are all familiar with the type of damage pests can do. Moths in the wardrobe, termites in the floor, mice in the pantry - pests can damage both buildings and collections, sometimes destroying them completely.

In the past, some museums undertook extensive fumigation schedules. However, this is both costly and can be damaging to collections. Today Integrated Pest Management (IPM) is favoured over a spray and pray approach.

This help sheet contains information about:

- checking for and responding to pest activity
- identifying pests
- Integrated Pest Management (IPM) and how to go about it
- Treating Insect Infestations

Checking for and responding to pest activity

What is at risk from pests?

Organic materials are most at risk from pest infestation . paper, textiles, and objects made of materials such as wood, plant materials and fur.

Some pests are attracted to materials made of cellulose . paper, starch adhesives and sizing . and others to protein-based materials, such as wool, feathers and fur. Some pests eat anything.

While not often directly consumed by most pests, inorganic objects (eg stone, metals and ceramics) can be damaged by general dirt and staining caused by pests.

What to look out for

Some signs that you may have a pest problem include:

- Holes, surface grazing or bite marks in objects. Borer holes are usually perfectly round, while moth holes are more irregular. Small piles of fresh dust often accompany borer holes.
- Droppings. (The polite term for insect poo is ~~poop~~ frass).
- Eggs. Insect eggs often look similar to pale poppy seeds.
- Some insects leave webbing from their larval stages.
- Some insects leave cases and cocoons from their larval stages. These can often be difficult to spot as they may be made from the object itself.

- Live insects, dead insects, and cast skins.
- Some pests, such as termites, can be heard chewing.
- Some pests, such as termites and rodents, can leave distinctive odours.

When to look

- **Spring**

Spring is the most important time to be watchful, as insect populations can increase quite suddenly with the warm weather.

However, regular inspections of vulnerable collections are important, as there can be insect activity at any time of year.

- **Once a season**

It is a good idea to inspect vulnerable collections at least once per season . vulnerable collections include most protein-based materials, such as natural history collections, feathers, furs, silk and wool. Other collections can be checked annually.

- **Loans, items returning from loan and new acquisitions**

It is also advisable to check all collections that are coming into the building before they are placed in storage, whether they are coming back from loan, new acquisitions, or collections from other institutions.

Where to look

Pests are more likely to be found in the following kinds of places:

- **Warm areas:** Check sunlit areas, windowsills, hot pipes, heaters, electrical equipment such as fridges and circuit boards, roof spaces.
- **Dark, undisturbed areas:** Look under and behind furniture and objects, inside the seams and pockets of clothing, and in floor, wall and roof cavities. Pests are more likely to move around the perimeters of spaces than across open floors.
- **Damp or wet spaces:** Look for leaking pipes or waterlogged material, or in humid areas such as bathrooms and plant rooms. Condensation on windows and pipes can also create humid pockets of air.
- **Messy spaces:** Pests will be attracted to garbage and debris, particularly if it contains food scraps. Check piles of paper, wood and other waste material. Pests are also attracted to dust and dirt, and to other dead insects . check your light fixtures and windowsills. Kitchens, bathrooms, loading bays and workrooms can all contain attractive rubbish for pests.
- **Plants and Animals:** Check any plants, flowers and firewood that may be used inside the museum. Look at the plants surrounding the building . do they grow close to the walls? Pests may use these planted areas to gain easy access to the building. Check eaves and gutters for plant and water build-up, and to remove animal nests.
- **New collections:** New material coming into the building is a potential source of infestations. Check all new acquisitions and incoming loans carefully before placing them on display or in storage. Boxes and packing material can also harbour insects.

When to worry

Finding one insect does not necessarily mean you have an infestation on your hands, especially if these are non-threatening species, like ants and large moths.

Casual visitors vs. long-term residents

Some museum pests, like **carpet beetles**, often find their way into buildings in spring and are found near windows and doorways. They may not yet have found their way into your collections. The best thing to do in this instance is to remain vigilant. If you notice more insects a more thorough inspection is warranted.

Silverfish are more permanent residents, but don't usually hang out in packs. Finding one or two indicates that conditions are suitable for them, but you may not have a huge problem on your hands.

Clothes moths, on the other hand, are rarely innocent. If you find clothes moths inside you can be fairly certain they are living within the building.

Dead vs. live

Dead insects and damage to collections do not necessarily mean you have a **current** infestation, as it may be that the damage occurred a long time ago.

If you find insect larvae, eggs, frass or small piles of fresh dust near wooden objects, this would indicate you have an **active** infestation inside your building. The infestation still may not be in collection material (eg it may be in debris inside roof spaces), but they must be treated as quickly as possible.

Finding adult clothes moths also probably means you have an infestation somewhere, as they tend to stay closer to their food source than some other insects.

What to do if you find an insect

- **Capture it** and place in a small glass bottle, vial or plastic container. **Try not to squash the insect** as this makes identification more difficult.
- Write on the container when and where you found the insect(s).
- identify the insect.
- Continue to check the area as part of your normal schedule.

What to do if you find an infestation

- Immediately **quarantine the affected objects** by sealing into plastic bags and removing from collection spaces.
- **Check nearby collections** to ensure there is no further infestation. Recheck the same area each week for a month, and bag any items you are concerned about.
- **Clean the area** if necessary. eg get rid of dead insects and debris.
- **Keep a record.** Write down the time, place and nature of the infestation then contact conservators and any other specialists who may be required.

Identifying pests

Why do I need to know what bug it is?

When you are faced with an infested item or collection, it is important to identify what insect you are dealing with. Correctly identifying insects enables you to determine if the pest poses a problem to the collections and to choose the most appropriate treatment and control methods.

Primary Pests

These insects are those that represent the greatest risk to collections. The accompanying pictures and descriptions will help you to decide what you have found.

Carpet beetle

There are many species of carpet beetle. One of the most common is the varied carpet beetle, which has a round shape covered with a pattern of grey and gold scales and is typically about 2-3mm long. The larvae of carpet beetles (short, hairy caterpillar-like things) tend to feed on protein-based material such as silk, wool, fur, feathers and animal specimens.

Adult carpet beetles often find their way into buildings through windows, chimneys and roof spaces. You may notice an influx after the **spring breeding** season.

Clothes moth

There are two main kinds of clothes moth. In both kinds, it is the larval form that does the most damage. The larvae of the clothes moth resemble small hairy caterpillars, and eat trails through collection material until they are ready to pupate into adults. The larvae tend to feed on protein-based material such as wool, silk and fur. They often prefer to feed on soiled or dirty areas of the object.

The larvae of the **case-making moth** form their cocoons from the material of the object on which they are feeding. This can make them very difficult to spot, as they blend into the object's surface.

The larvae of the **webbing clothes** moth leave trails of webbing mixed with dirt and droppings behind them, which makes them a much messier infestation.

The adult moths of both species are small and grey-brown, and tend to scuttle rather than fly. They are about 5-7mm long. When at rest their wings are folded along their back.

Silverfish

Silverfish are long, silver-coloured insects that often graze on the surface of paper-based material. Silverfish can grow up to about 7mm in length. They especially like to feed on glues and adhesives. Silverfish prefer quite humid conditions, but may migrate from their damp breeding spaces into collection spaces.

Silverfish have a nymph stage rather than a larval stage. That is, the young silverfish just hatched from its egg looks exactly like an adult, only much smaller.

Book lice

Booklice graze on microscopic moulds that grow on the surface of paper-based material, leaving surface damage similar to that caused by silverfish. They are also attracted to glues, binders and paper sizing.

Booklice are usually very tiny (less than 1mm in length) and are a slightly transparent brown colour. They do not have wings.

Wood-boring Beetles

There are many species of borer beetles that infest wood, including **furniture beetle**, **drugstore beetle** and **powderpost beetle**. Species that affect collection material can be between 2-6mm long.

Borers chew through wood, paper and books and leave networks of tunnels with perfectly round exit holes. Borers can be difficult to detect - piles of fresh dust at the base of holes are one of the only ways to detect an active infestation. Borers may also affect building materials, display cases, storage cabinets and other furniture.

Termites

Termites are not commonly found in collections but can pose a serious problem to the building itself. Termites have also been found in large stacks of paper, and in various wooden objects. Outdoor sculpture may be at a higher risk of termite infestation.

Termites may actively consume collection material or the object may become damaged due to its proximity to the nest. Termites create very humid conditions, so mould may also become a problem.

There are three main types of termite: subterranean, drywood and dampwood. Subterranean termites usually cause most damage to buildings; drywood termites usually cause most damage to objects, unless subterranean termites have gained access to the item through the ground or floor.

Signs of damage can include changes in the appearance of a wooden surface, as material is being eaten away behind it. Subterranean termites will block up any holes in the wood with hard piles of dirt and wood particles, which are visible from the outside. This is done to maintain the temperature and humidity of the tunnels. Sometimes you can hear termites chewing.

Spider beetles

These are often found in bird nests and museum collection and will feed on any general debris, including dead insects. The larvae are large and hairy and will bore holes in objects. The adults are 3-4mm long, hairy and superficially resemble spiders, but are generally slow-moving. Often only one will be found . this is not a serious problem.

Biscuit beetles

These belong to the same family as the wood-boring beetles, but bore into hard, dried vegetable material such as biscuits, tobacco, nuts and dried plant specimens. They may also attack high-starch paper objects (eg papier-mâché) and freeze-dried animal specimens.

Adults are 2-3mm long, very active and will fly. Larvae are not very active and will concentrate their activities in one area, leaving neat exit holes in objects.

Hide and leather beetles

Hide and leather beetles may attack wool, fur, feathers and textiles but will also attack leathers and skins. The adults are larger than carpet beetles (6-10mm). Larvae are large and very hairy.

Secondary pests

The pests listed below are usually no cause for panic, but should be prevented from living in or near your building.

They are commonly found in and around buildings but are not usually directly threatening to museum collections. Some, like cockroaches, have been known to feed on collection material, but more usually these pests stain or dirty objects or surfaces, and act as a food source for other insects . bugs love to eat other bugs!

The presence of these pests indicates that conditions in your building are suitable for insect growth and that alterations may be needed in your cleaning and maintenance procedures . for example, a healthy spider population indicates that you probably have healthy populations of other insects.

- Millipedes
- Centipedes
- Wasps
- Spiders
- Ants
- Cockroaches
- Birds
- Rodents
- Bats
- Crickets
- Large moths

Integrated Pest Management (IPM)

What is Integrated Pest Management?

Integrated Pest Management (IPM) is the term used to describe a coordinated approach to pest management that does not rely on chemicals and so moves away from the 'spray and pray' approach.

IPM focuses on making the museum environment unattractive to insects and other pests through physical exclusion, good housekeeping and early detection. It relies on knowledge of the pest's life cycles and habits, good management and monitoring of the museum environment, inside and out.

Chemical methods do have a place in IPM programs, but their use is minimised.

Why not just spray?

Many chemicals used as pesticides in the past have been found to have damaging effects on people and objects.

As knowledge of the risks associated with pesticides and other chemicals has grown, museums have tried to minimise their use to protect their workers and their collections.

Chemicals often do not address the whole problem. For example, using a 'flea Bomb'-style of chemical will knock down adult insects in the area, but is not likely to affect insects protected by fittings and furnishings. Eggs are also unlikely to be affected. Therefore you end up having to re-treat the area again and again, as the original source of the problem has not been contained (eg a cat without a flea collar).

Commercial sprays can still be used to quickly treat active infestations, but be aware that they may not be removing the source of the problem. If sprays are used it is important to minimise any contact between the chemical and collection items, as staining and colour change may occur.

Components of IPM

The basic components of an IPM program are as follows:

- **A regular cleaning and housekeeping schedule**, to remove food sources and clutter.
- **A regular building maintenance program**, to block entry points to the building.
- **Sound storage containers**, to prevent insects from gaining access to collection material.
- **A quarantine area** for all incoming material.
- **Regular inspection** of storage areas and collection material, to check for insect activity.
- **A regular program of trapping insects** (using sticky traps), to keep track of resident insect populations.
- **Written records** of all IPM activities.
- **Awareness.**

Housekeeping

Insects are attracted to food sources and general clutter. Keeping your storage and work areas clean can make a huge difference to your pest problems.

- Keep plants, food, firewood and rubbish out of storage areas, and empty inside bins daily.
- Keep any kitchen areas clean, and avoid leaving water on benches.
- Do not leave material on floors, and avoid creating piles of rubbish/boxes/junk etc.
- Keep storage spaces clean.
- Vacuum rather than dust.

Building maintenance

Keeping your building in good repair prevents insects from gaining access.

- Maintain and repair leaks, vents and gaps in walls, floors and doors.
- Place doormats outside external doors and sweep entrances regularly.
- Place fine screens over vents, drains and windows (if opened).
- Clean gutters, clear nests from roof spaces and eaves.
- Do not allow plants to grow up walls; maintain plant-free zone of at least 1 metre around building. Try to avoid having overhanging branches.

Storage

Placing collection material in clean, sound storage containers provides another layer of blocking against pests. Avoid packing material too tightly inside boxes and on shelves, as insects and mould favour conditions with low air circulation and/or disturbance.

Quarantine

Check all incoming material for insect infestation, including packaging, before placing in storage - this is one of the most common ways that insect infestations take hold. Have a separate quarantine area for this purpose. If insects are found, seal the affected material inside a clear plastic bag and contact a conservator.

Inspection

Inspect premises and collection regularly. (Monthly is good, but seasonally is more realistic). Check in, under and behind furniture and objects, as insects are more likely to live in dark, low-traffic areas. Inspect roof spaces, floor spaces and eaves if possible. Use a torch. Record all findings in logbook. Remove any infested objects to quarantine area and place in sealed plastic bag for treatment.

Trapping

Sticky traps should be laid around walls and near doors, windows and vents. Traps should be placed along the wall, not at right angles to them. Mousetraps should also be placed in this way, in easily accessible locations . avoid using baits and poisons (rodents tend to die in inaccessible areas, causing more pest problems).

- Aim to have at least 6-8 traps in a medium-sized room, and number each trap and map its location.
- Check traps regularly (monthly is good, but seasonally is more realistic) and note what insects are found. Also make a record if no insects are found.
- Mousetraps should be checked daily.
- Replace traps when more than five insects are present, when trap has lost its stick, or when past use-by date.
- Keep insect bodies in vials as voucher specimens and for identification.

Written Records

Keep a logbook of all your IPM-related activities, so that you can build up a record. Over years you may start to see seasonal patterns occurring - this can help you plan IPM activities more efficiently.

Awareness

Anyone working with the collection or in the building can help with an IPM program. Staff and volunteers can keep an eye out for insects and insect damage, as well as building maintenance and cleanliness issues. It can be helpful to have a single person to whom staff can report, and who will coordinate a response to the problem.

Suggested materials for an IPM program

Name of Product	Number of units	Supplier
Sticky traps (without baits or pheromones)	Keep about 20 in stock, in addition to those in use	Pest Control Companies or suppliers
Torch (for inspections)	1	Hardware store
Logbook (eg spiral-bound notebook)	1	Stationery store
Insect Identification kit	1	Artlab is currently producing a kit; alternatively purchase an appropriate book
Small plastic containers	10	Medical or labware suppliers; supermarket.
Building map, with traps marked	1	Generate internally
Clear polyethylene plastic bags (large) . oven bags or similar would be fine	Keep about 10 in stock	Supermarkets

Treating Insect Infestations

Physical removal

Often it is possible to merely clean items in order to treat an insect infestation . for example, by removing insects and debris with tweezers, a soft brush, and or gentle suction. This is often suitable for flat items, like documents, framed prints and photographs.

However, this is not suitable in all cases. For example, it is exceedingly difficult to physically remove insects from inside the lining of a coat or some curtains, or from the spine of a book. In this case, other treatment methods are required.

NB: Regardless of the treatment method chosen, it is still important to remove as much insect matter as possible, so you don't mistake an old, dead infestation for a new one.

Modified temperature treatment methods

Insects require oxygen and comfortable temperatures to survive. They are most active between 15-25°C but can still be active beyond this range. A rapid drop or rise in temperature is required to kill all stages of the insect life cycle, from eggs to larvae to adults.

Modified temperature treatments are useful in that they are readily available, affordable and do not require highly specialized equipment.

The types of modified temperature treatment methods are:

- Freezing: safe for many objects and widely used
- Heating: moderately safe for some objects and less widely used

Freezing

The current recommended guidelines for the successful eradication of insects are to freeze infested items at . 20°C for a minimum of 7 days. However, not all items can be frozen safely (see *Table 1*).

Preparing objects for freezing

Reducing the change in moisture content of objects is the most important safety consideration during freezing.

- Place infested objects individually in plastic bags (polyethylene) or plastic containers to protect against the formation of condensation during thawing.
- Evacuate as much air as possible from the plastic bag in order to reduce the amount of moisture transfer.
- Add buffering material such as crumpled paper tissue, cotton towel or sheets to absorb excess moisture. (This is especially important if you are freezing materials that can be damaged by this process).
- Seal the bag or container.

The freezer

The freezer must be capable of dropping to . 30°C when empty, to ensure it can drop to . 20°C when full. If the freezer is only capable of dropping to . 15°C when full, leave infested objects inside the freezer for 14 days.

Chest freezers are the most suitable for freezing objects. Do not use cyclic defrosting freezers because the temperature varies during the defrosting cycle, which allows insects to remain dormant.

Packing objects in the freezer

Take care when handling objects, especially when they are frozen, as they will be more brittle. Avoid packing objects on top of one another, and provide supports for fragile objects as necessary.

During freezing

The objects must receive a sudden drop in temperature to . 20°C and then be held constant at that temperature for the entire period of 7 days. Do not open the freezer once the objects are placed inside, as the temperature will increase and the insects may not be killed successfully. Put a padlock on the door if necessary!

After removal from the freezer

Take care removing objects from the freezer - they will be solid and brittle. It is critical to leave the objects in their sealed containers while they slowly return to room temperature . this usually takes about 24 hours.

Table 1: Material types for freezing

<p>Materials that can be frozen safely</p> <p>Be aware that many items are composites of different material types, not all of which may be able to be safely frozen. For example, a textile may include glass beads or metal buttons.</p>	<p>Books</p> <p>Coated papers</p> <p>Feathers</p> <p>Newspapers</p> <p>Organic fibres - eg basketry, tapa cloth</p> <p>Paper files, records and maps</p> <p>Textiles</p> <p>Soft toys</p>
<p>Avoid freezing</p> <p>These items are particularly sensitive to moisture and dimensional change and/or become brittle and crack during freezing.</p> <p>Adding buffering material such as clean cotton towels or sheets when freezing metals, bone, ivory, highly fired ceramics or</p>	<p>Animal mounts and study skins</p> <p>Audio and video tape</p> <p>Bone and ivory</p> <p>Computer disks, CDs and CD-ROMs</p> <p>Ceramic</p> <p>Daguerreotypes, ambrotypes and tintypes</p> <p>Ethnographic items with mud, ochres and other friable</p> <p>Film-based material (eg motion picture film, microfilm)</p> <p>Fur</p> <p>Glass, glass plate negatives and lantern slides</p>

<p>waterlogged objects will help to prevent damage, but be aware that damage may occur.</p> <p>Avoid freezing paintings, glass, wax and some plastics and rubbers . damage is almost certain.</p>	<p>Leather</p> <p>Metals (including textiles with metal buttons or threads)</p> <p>Paintings</p> <p>Parchment and Vellum</p> <p>Photographic prints, negatives and transparencies</p> <p>Plastic</p> <p>Records . vinyl, shellac and acetate</p> <p>Wooden objects, especially if waterlogged</p> <p>Works of art on paper</p>
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Heating

The recommended guidelines for the successful eradication of insects are to heat items to 52°C for 4 hours. The most useful application of heat treatment is in the field, where freezers and other equipment may not be available.

Heat accelerates deterioration reactions in most materials and thus is damaging to collection items. However, as the exposure period is short, it may be worth causing this damage in order to eradicate a bad insect infestation.

Do not heat materials that are sensitive to high heat, including glass, wax, resins, adhesives and leather.

Simple sunlight heat treatment

This is a cheap and easy method for to treat insect infestations.

- Make a bag from black plastic to the size of the infested object.
- Make another slightly larger bag from either black or clear plastic (polyethylene).
- Place the infested object inside smaller bag.
- Evacuate as much air as possible from around the object and seal the smaller bag.
- Place the smaller bag inside the larger bag and seal.
- Place the double-bagged object on a screen or chair in sunlight for 4 hours. Do not place the bag on the ground, as heat will be absorbed into the ground. The outside temperature must be at least 25°C to ensure the temperature inside the bag will reach 50°C. Double bagging allows the heat to be maintained longer in case of cloud cover.