HISTORIC
NEW ENGLAND
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# INTEGRATED PEST MANAGEMENT


## SUMMARY

Integrated Pest Management (IPM) is a holistic method based on preventive measures rather than pesticides alone to mitigate the damage done by biological infestations. IPM is based on the understanding that all pests (animal and plant) need the following to survive:

- Food
- Water
- Harborage (a place to live)

Disrupt any one of these factors and the "undesirable" pest will not flourish. It should be noted that the concerns are *reducing* the pest problem. It is neither desirable nor realistic to be able to completely eliminate or kill any one species out. Many pests, insects in particular, are highly adaptive. It would be nearly impossible to wipe them out. While pesticides are still an option for difficult and extreme cases, their use is limited and targeted to a very specific problem.

*An effective Integrated Pest Management plan relies on a combination of good housekeeping, monitoring, and targeting problems to stay on top of pest troubles.* An aggressive, proactive approach such as the one outlined here can significantly reduce the number of infestations that occur. The approach to a successful IPM plan is one which uses non-invasive methods to prevent or at least minimize the risk of pest infestation. This approach has considerable advantages regarding health and safety, being less harmful to both humans and the environment, and once established is also likely to be more cost effective than a passive or reactive approach.

*Pests that come into contact with collections can be grouped in three main categories*:

- Vertebrates- mice, rats, bats, birds, and squirrels
- Insects- sometimes merely a nuisance, insects may also be agents of destruction. They are the most common and often most difficult pests with which to deal.
- Mold and Fungi- though not pests in the usual sense of the word, they are commonly grouped with pests because they are often treated chemically and conditions allowing them to form can also be attractive to other pests.

*Correctly identifying the specific pest(s) and the degree of infestation is essential in designing an effective defensive strategy.* When battling insects, it is important to understand their:

- *life cycle*
- *eating habits*
- *environmental needs.*

*Currently, the majority of pest problems at the storage facility in Haverhill are classified as protein feeders.* The pests listed below are ones that have been found and identified on site, and currently pose a threat to the collections:

*Clothes Moths*- The adults can many times be seen flying off of disturbed objects, and since they are not great flyers, are walking along walls or window sills. They are difficult to spot, as they tend to tunnel on the undersides of fabrics and prefer dark conditions. They attack wool, fur, feathers, hair, any animal fiber, and will eat through other fibers (including synthetics) to reach the desired food source. They are particularly attracted to fibers soiled with grime, food, or perspiration. The larvae do the most damage as they feed.
There are two species of wool or clothing moths: The casemaking clothes moth (*Tinea pellineollae*) and the webbing clothes moth (*Tinea bissellilla*). The larva looks like small white worms with dark heads. The casemaking clothes moth makes a cocoon out of the fibers it eats and drags it along with itself as it feeds. The webbing moth larva waits to make its cocoon until it is ready to pupate, although it too, uses fibers it is eating to construct the cocoon. The adults are small, plain-white to buff colored moths with a fringe on the back of the wings. They *avoid* light- and will generally flutter about if light is suddenly present, as they are not very good flyers. The adult moths do not eat, existing only to breed and lay eggs.

*Dermestids*- This large pest group, commonly known as carpet beetles, include several varieties. Though small, they vary in size from species to species (2mm- 9mm). They are generally dark brown or black, and some may exhibit yellow or orange patterns. Like moths, it is primarily the larvae which do the most damage, but the adults of some species can also cause damage. The larvae may attain a length of up to ¼" and all have tufts, or tiny hairs. It is the cast of larvae skin (known as molts) that may be the first sign of infestation. If suspected, also look for signs of loosened strands on hair decorated artifacts, loosened rug pile, or holes in textiles. These insects can also be attracted initially to insect carcasses. They like dried animal and plant protein including, wool, silk, fur, hair, horn, bone, skins and hides, feathers, seeds, spices, and drugs.

*Woodborers* or *Wood Feeders*- The presence or evidence of these pests pose more of a threat at the specific house sites, than at the collections facility. This is because of the proximity to seasoned timber, from which beetles particularly, emerge from the wood to mate, and immediately lay their eggs in wooden objects, and furniture. Evidence of

powder post beetles (*Lyctus brunneus*) have been found at certain sites. They can be recognized by the characteristic dust and frass which falls from larval tunnels. Infestation by powder post beetles is easily diagnosed by the presence of very fine talc-like powder around damaged objects, and in severe cases will reduce wood to a powdery mass surrounded by a paper thin-shell. The adult female will lay the eggs in the wood, and the developing larvae will feed their way through wood (tunneling), and after about one year's development, the emerging adults will exit the wood and leave 1.5-2mm diameter exit holes. They prefer deciduous hardwoods such as oak and tropical hardwoods.

*General Feeders*- Specimens such as the cigarette beetle (*Lasioderma serricorne*) have been caught and found in the sticky/pheromone lure traps on the 5$^{th}$ floor of storage. They often eat mold, starch, and are generally considered more damaging to paper and dried foods, although they will also feed on other protein sources. The large collection of wallpaper and wallpaper samples on the 5$^{th}$ floor is a targeted concern, with the discovery of the cigarette beetle.

## HISTORY OF PEST MANAGEMENT AT HISTORIC NEW ENGLAND –SPNEA

The alarming discovery of an upholstered chair, infested with varied carpet beetles, alerted me to the needs and demands of an implemented IPM for our storage facility. Considering the seriousness of our situation, I am working on a *response and recovery first*- which was brought on by finding not only one object infested with carpet beetles, but many more to follow suit. In a situation such as this, the first step is to take immediate action- with prevention and planning to follow suit. The development of the IPM plan will follow suit concurrently and accordingly during the current response and recovery stage. Some mitigation and treatment strategies have already been enforced, and there is an excellent housekeeping manual (which is revised and updated annually).Since there is currently no formal IPM plan in tact, it is imperative that one be created and put into practice immediately, as to avoid and minimize the risk of a full-blown infestation. Attempts to eradicate pests have been a function in the museum since its inception. Many of the objects that are in collections are highly susceptible to damage or destruction caused by biological agents (biodeterioration). Many of these agents are considered irritants and highly hazardous to humans, and still pose serious health concerns to staff, public, and the environment. Pesticides have traditionally been used in attempts to eradicate insects and rodents, and while hazardous to humans and collections, are many times ineffective in eliminating pests. Pests are extremely adaptive and can develop immunity to pesticides.

## GOALS OF IPM

The main goal of the IPM plan is keep the facilities free of pests. It connotes the control to minimize the risks of pests that attack and damage collections. The term pests denote insects and other arthropods, rodents, mold, fungus, and anything that does not belong inside the building.

IPM consists of the following activities:

- *Monitoring:* regular monitoring of the facility for the types and numbers of pests that have infiltrated the building structure and are a threat to collections

- *Housekeeping*: Control and careful cleanup of food wastes and keeping all areas clean of all debris that is attractive to pests- including other pests

- *Building Maintenance*: Keeping the building fabric/structure in good condition to prevent the entry of pests through cracks, gaps, etc.; this includes gasketing doors and windows, keeping plants and growth away from the exterior of the building, controlling temperature and R.H. within all spaces in the structure

- *Reducing/ Minimizing*: Controlling the pest species through the sensible and sparing use of chemical insecticides, fumigants, and fungicides on a regular and as-needed basic. Emphasizing the use of non-chemical treatments such as modified atmosphere treatments, and other methods of temperature control like freezing and heating, and the use of sticky traps and pheromone lures.

***METHODOLOGY***

*Monitoring* of all spaces included in collection areas are subject to infiltration and habitation by various pest species and will be monitored with sticky traps and the use of appropriate pheromone lures.
The keys to successful insect trapping are as follows:

- Use commercial 'tent-type' style traps.
- Survey the area, prepare a plan and decide where to place traps. Traps should be placed in a regular grid pattern against wall floor angles- preferably in corners, around drain pipes, and under shelves and storage units where insects tend to harbor- not in the middle of a room or in open areas. Date-label traps and mark their position on the floor plan
- Traps should be checked regularly (every 3 months). Considering the current infestation situation, traps will be monitored and checked once per month.
- Insects caught should be properly identified using resources available. Note whether they are larvae or adults
- Traps should be replaced when they become exceedingly dirty/dusty, or if large numbers of insects have been caught. (It should be noted that while insects attract other insects, trapped insects are considered another food source- which is to be kept to a minimum)
- The trapping program should not overwhelm the resources available, although more traps will generally catch more insects.
- While used over a long period of time, a record of catch and location will build an accurate picture of the distribution of insects.

**Pheromone Lures-** Many insects produce attractant chemicals called sex pheromones to lure mates. Some of the pheromones of museum pests have been identified and a few are available as synthetic lures to use with traps. Because of the varied behavioral response to pheromones, placement of these traps is more complex than simple sticky traps alone. The pheromones will generally only attract the target species and may even repel other insects. It is important to note that on the on the 5th floor of storage, I have found a number of pheromone trap/lures used specifically for varied carpet beetles that have been attracting cigarette beetles. While the pheromone lures are targeted to attract the sexually-mature, adult males only, there has been evidence of larvae found in some of the traps. The lures are also far more expensive than simple traps, so they should be used in areas where there is a high risk or where one of these pest species is suspected. Additionally, the lures are quite potent and can potentially attract 'unwanted' pests, which makes placement of the lures/traps even more important.

*Note on Webbing cloths moths-* The flight activity of the males is stimulated by the pheromone and suspended traps provide a very useful early warning of infestation. When temperatures are high enough to promote flight, up to 20 times as many moths may be caught on traps with pheromone lures as on un-baited ones. Below 20°C/ 68°F, the males are reluctant to fly and the suspended traps are relatively ineffective. In these situations, the pheromone can be placed on sticky traps on the floor.

**General Principles of Insect Detection and Monitoring**

- Timely scheduled and systematic checks and inspections are more effective than one 'blitz' inspection.
- Concentrate on dark corners and dead spaces, in addition to high-risk objects.
- Look on window sills and other areas like air-conditioning ducts and filters, and be sure to check for piles of dead flies- which provide an ideal food source for carpet beetles.
- Look in cases and storage boxes, under objects, pockets and seams on textiles and clothing, inside wooden objects, and behind the polished veneer front of furniture.
- Pellets of frass, silk webbing, or cast skins of larvae (molts) are frequently the first signs of infestation.
- Inspection for seasonal pests such as adult carpet beetles is best carried out in late spring and early summer when they are active and flying.
- Keeping objects and their environment clean and free from dust will make evidence of molts and fresh boring activity obvious- a dirty store will make it difficult to distinguish old infestations from new.

**Building Maintenance/ Exclusion**

Adult beetles, carpet beetles, and clothes moths can fly in from sources outside the building. Adults and larvae may crawl in from adjacent, infested areas or objects. It

is therefore important to try to keep un-infested objects free of pests by making it difficult as possible for the pests to get at them.

- Seal windows that are never opened
- Fit doors with bristle strips or gaskets
- Plants, shrubs, and trees adjacent to outside walls should be kept well pruned as they can create pest harborage and provide a route into buildings

The building situation here is a unique one, as we share the facility with other tenants, making it somewhat difficult to fully control and monitor the exterior/interior environment. It is imperative that we continue to work closely with building maintenance so that they clearly understand our needs for an effective IPM plan. Developing a good relationship with building maintenance and housekeeping is essential.

**Environment**

The influence of temperature and RH on the prevention of infestation is crucial as insects need warmth and humidity to thrive. The main environmental objectives for insect pest prevention in storage areas are:

- Keep the temperature low
- Keep the RH low
- Limit variations in temperature and RH
- Keep the environment and the objects clean

**Temperature and RH**

Warm temperatures of 20°C/ 68°F and above will encourage insect breeding so cool temperatures are recommended. When monitoring for insect pests, inspect near heating pipes and in ducts, which are far warmer than the rooms they are supplying. Many insects can survive at low RH, but usually when the area is damper. Some species have declined with the use of central heating which reduces RH levels. Silverfish and booklice will only breed rapidly and cause serious problems in conditions above 70% RH.

**Housekeeping and Hygiene**

Cleaning is 99% of successful pest prevention in an IPM program. Pests thrive in a dirty environment and dust, debris and rubbish provide shelter as well as food. Furthermore, cleaning is the most effective and cost-efficient method of good IPM. While cleaning collection objects does require some special equipment and special care- it is mostly common sense and good judgment. The *Historic New England –SPNEA Housekeeping Manual* is an excellent reference which is updated annually.
It is suggested in many IPM procedural outlines to thoroughly vacuum storage and collection areas once a week. However, because of the size of the collection

area(s), the number of objects, and the availability of staff resources- a once per week housekeeping schedule is neither practical nor realistic. Therefore, it is suggested that the storage areas be vacuumed thoroughly at least twice a year- preferably in the spring and in late summer- when insect pest activity is at its peak. Some general guidelines for inspection and cleaning:

- Thorough vacuuming of the aisles and rows on 3rd, 5th, 6th, and 8th floors.
- Make sure to concentrate on corners, under objects and shelves, along window sills, and around heating and drainage pipes.
- Use a flash light to inspect under objects and shelving units
- Inspect and vacuum in gaps between walls and floors, and in cracks.
- Vacuum between and around all objects (yes- this can be a daunting task!) It is important to use common sense and be practical- all high-risk objects are of primary concern, first.
- When inspecting objects, look inside trunks, cabinets, drawers, etc.
- Any food or drink left in 5th floor kitchen should be cleaned up immediately
- Trash should be emptied out regularly- especially after events and meetings
- Avoid 'piling' or 'stacking' objects and items in or near corners
- Clean windows sills of cluster flies- which provide an ideal food source for carpet beetles.

## PROCEDURAL GUIDELINES FOR DEALING WITH INFESTATION

The guidelines set below are to be followed as aid of prevention and response:

1. Since a large percentage of the collection is comprised of organic material(s), it is imperative that a thorough visual inspection take place for all objects that fall under threat to insects and pests. This includes any and all objects that have materials that include- paper, wool, wood, bone, ivory, animal hair and animal hide, feathers, silk, and any other organic material.

2. Once infested object(s) are discovered, isolate the suspected pest(s) by saving a specimen in a plastic bag. Identify and study them to understand their biology, their habits, their preferred food choices, and how to get rid of them. *This is a key element to getting rid of and preventing the return of pests.* Use resources that are available, and call for the help of a professional and/ or specialist to help identify and understand the situation, if necessary.

3. Immediately isolate the object(s) in question, or ones that are obviously infested. If there is evidence of infestation, but no live activity is seen, always aid on the side of caution- ask other staff if the object has gone through previous treatment, or has a history of infestation. Wrap object in plastic, quarantine it and watch it carefully for a few weeks- then inspect for activity.

*Specific guidelines for wrapping and isolating infested objects are as follows*:

- Objects should be wrapped immediately in .6mm polyethylene sheeting. **NOTE:** If objects are also damp and wet, the Conservation Team should be consulted BEFORE sealing them in plastic.
- Wrap the object(s) tightly to squeeze out excess air, but carefully- to not damage the object.
- Seal all folds and corners are sealed with tape to prevent the escape and migration of pests. It is interesting to note that the pests do move quickly towards the seams and the corners in an effort to get oxygen, once the object(s) have been wrapped and sealed. Keep in mind that it is impossible to create a 'complete' seal, especially when using common polyethylene, which has high oxygen permeability. Only special barrier-film- type laminate plastics can allow for this type of 'sealing.'
- It is especially important when wrapping furniture, that the bottoms of the legs/ base are given extra re-enforcement with plastic and tape because this is an area where the plastic will easily tear and give way. This allows air flow and an easy escape for the pests, which is to be avoided.
- Move all objects to an isolated "quarantined" area. A quarantine area should be designated for the holding of infested objects en route to anoxic CO2 treatment in the bubble.

4. Areas adjacent to where infested objects have been found should be inspected for the migration and spreading of insects- look in corners, cracks, along walls, around pipes- any place where insects are inclined towards (dark, and/or humid and environmentally stable areas are ideal hiding places). Most importantly, because of the 'tight' storage situations and the high volume of objects in storage, any and all surrounding objects should also be inspected for activity and/or infestation.

5. Once the species/type of insect has been identified, steps should be taken to control and prevent the insects from returning and causing more problems. This would include a thorough vacuuming of objects and the storage area, paying particular attention to areas such as windows, cracks, corners, along walls, drain pipes, heating units- anywhere insects are inclined to take refuge and seek harborage. Many of the objects in storage make potentially safe homes for insects with hearty food sources.

    - Objects that are on the floor should be raised off the ground, either on shelves or with the use of ethafoam blocks.
    - The use of sticky traps and species- specific pheromone lures should be used to aid in the detection and capture of insects. The traps and lures should be

placed in key locations where insects have been, and where they are most likely to harbor. The traps and lures are beneficial because they will catch insects, and will also be helpful in keeping track of activity within area(s) of storage.

- The use of harsh chemicals and pesticides should be kept to an absolute minimum, as these are hazardous for humans are potentially hazardous to the collection.

6. Once traps and lures have been set up, a floor plan of storage should be drawn with indications of where traps are located and where problems areas are. It will be easier to track and control the insect activity.

    - An activity log should be posted on each floor of storage indicating row and section areas, trap locations, how much and what kind of insect activity, and the date and time.
    - The Collections Technician should be responsible for the activity log, and for making monthly rounds for the first year following the infestation incident(s).
    - Other staff members should be aware of the activity log and take responsibility to log in incidents and notify the Collections Technician of such incidents.

7. Thorough cleaning and vacuuming should be done for all of the storage areas a minimum of twice a year for two years following the infestation incidents(s). After that time, if insect activity is under control and kept to a minimum, then a rigorous cleaning can be done once per year, preferably in the spring- when insects are most active.

8. Any objects brought to the storage facility should be thoroughly inspected before the object(s) is allowed to enter the storage facility. This would include any objects returning from loan and travel, donations, gifts, and any infested objects that are brought to our attention, and scheduled for CO2 anoxic treatment.

*MODIFIED ATMOSHPERE TREATMENTS- ANOXIC CO2 TREATMENTS*

This method is many times referred to as 'carbon dioxide fumigation.' The preferred term is modified *atmosphere treatments, or anoxic CO2 treatment.* Fumigation is a term which is frequently used for almost any insecticide treatment and the use of toxic fumigant gases. CO2 is an inert gas, but it is potentially dangerous to humans if exposed to extremely large doses. In the UK, for example, CO2 is registered as an insecticide and can only be used by professional operators.

At present, all infested objects at Historic New England –SPNEA are treated using the carbon dioxide anoxic chamber. Since we have an on-site unit, space availability, and proper resources, this method is the ideal choice for treatment of infested objects.

Additionally, the process involved is relatively safe for most all materials. This of course holds true when proper guidelines and methods are followed to ensure proper treatment. Once objects have been put through treatment, they should be appropriately cleaned and inspected for any pest activity. In some cases of heavy infestations, it is necessary to put the object(s) through another anoxia treatment. Once cleared, they should be returned to their corresponding storage location.
Other viable treatment methods that are effective and can be considered:

*Physical control*- careful inspection and removal of insect larvae, pupae, and adults from objects may be a viable and effective method of control. The limitations depend upon the pest species involved, the nature of the object and the ease with which it can be inspected. Vacuum cleaning can be used to supplement the inspection. Objects should not be cleaned without seeking the advice of a conservator to ensure that the integrity of the object is not compromised.

*Freezing*- Freezing kills insects by rapid temperature change. It is a widely used treatment for many objects, such as natural history specimens and textiles, and when proper procedures are observed, there is no damage to objects. However, composite, fragile or unstable materials should not be subjected to extremes of temperature. There are a number of very good resources that reference proper methods of freezing.

*Heating*- Heating will kill insects more rapidly than freezing but it is essential to ensure that elevated temperatures do not harm objects. Many insect pests will survive temperatures up to 40°C/ 104°F and unless great care is taken, the effects of higher temperatures needed to kill insects may be more damaging to objects than the pests. Most pests are killed in a few hours, and washing textiles in water above 60°C/ 140°F will usually kill developing insects (Strang 1992; Han and Vagn Jensen 1996, 1998).
Recent work has shown that damage due to shrinkage and distortion caused by heating can be eliminated by controlling the RH around the object. There are a number of very good resources that reference proper methods of heating.

*Oxygen scavengers*- A number of museums now use a gaseous oxygen scavenger for treatment of individual specimens. Ageless Z™, the best known of these, is composed of moist active iron oxide powder encased in a porous packet. Oxygen in the atmosphere penetrates the packet and further oxidizes the powder. A slight amount of heat and moisture is produced by the reaction, but if the packets are spaced apart and kept out of contact with the object(s) then it does not build up enough heat to damage the material being treated. The small amount of additional moisture will have no measurable effect on well-buffered absorbent materials such as textiles. More sensitive non-absorbent materials can be wrapped in buffering cloth or acid-free tissue paper. More information is readily available regarding the use of oxygen scavengers as there are a number of resources.
There are a number of other treatment methods used and available- some non-toxic and some toxic. However the ones listed above are some of the more widely used and safe, non-toxic methods that are preferred over more experimental and hazardous treatment methods.

## STAFF EDUCATION

The most valuable resource of any museum is its staff and it follows that effective pest management makes the best use of everyone. Successful pest prevention and control relies upon good communication between all those responsible for the collection, and combine all of the different expertise.

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