


**Developing an Exclusion Program for Cockroaches & Rodents**



Matt Frye, PhD  
NYS IPM Program  
Cornell University

**Rodents & Human Health**

BACTERIAL INFECTION CAUSED BY RAT URINE IN BRONX KILLS 1, SICKENS 2 OTHERS



plague, typhus, Lyme, hantavirus, allergies, food-borne illness...



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**Cockroaches & Human Health**



one fecal spot sensitize & sustain allergies  
mechanically vector bacteria on feet

**Exclusion is Pest Prevention**

Pest reduction via traps and poison will not prevent disease problems.

Exclusion can.



Hugo Hartnak, 1939  
202 Common Household Pests

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**Exclusion in Pest Management**

“Exclusion” is widely recognized, but..

- Practices are not standardized
- Available resources are not promoted

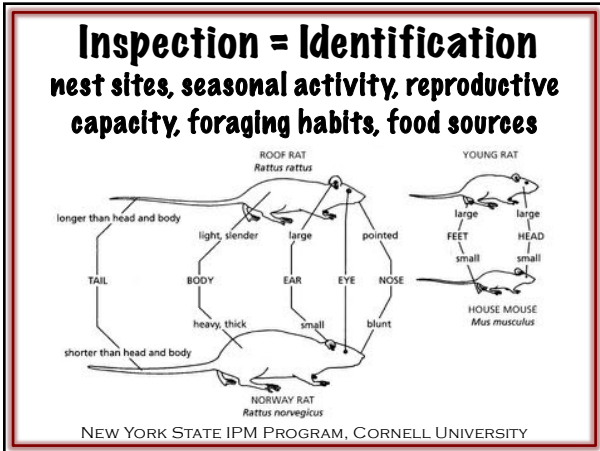
**Your services should include exclusion**

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**Developing a Program**

1. Inspection
2. Prioritization
3. Tool & Material Selection
4. Implementation
5. Evaluation

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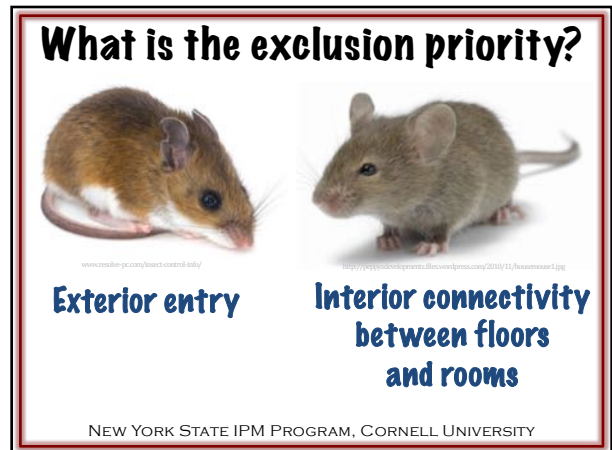
### Target Pest Influences Plan

**Which mouse is a permanent resident?**  
**House Mouse**

**Which mouse is seasonal?**  
**White-footed Mouse**

**Which mouse is found in urban areas?**  
**White-footed Mouse & House Mouse**

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## Sex Matters

	House Mouse	Norway Rat
Number of litters	6-8	2-7 [4]
Pups per litter	2-16 [5]	6-14
Total production per female	42-60	36-39
Female sexual maturity (days)	35-60	75-90
Age at weaning (days)	21-28	28

**Are you catching females?  
Replacement occurs quickly**

Adapted from Corrigan 2011, Mallis Handbook  
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## "Sexing" Rodents



**Distance from anus to genitals  
Presence of vaginal orifice in females**

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## "Sexing" Rodents



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Site Name \_\_\_\_\_ Address \_\_\_\_\_ Inspector \_\_\_\_\_  
 Site Contact \_\_\_\_\_

**IPM** Integrated Pest Management

### Rodent Monitoring Log

Date	Device #	Device Type (optional)	# Rodents	Rodent Species	Rodent Age	Rodent Sex	# Droppings	Observations: directionality, rodenticide exposure (droppings color, baited or runway trap, entry point, food source, water source, harborage, etc.)

**Device Type**  
 MCT: Multiple Catch Trap  
 CT: Clear Trap  
 WST: Wooden Soap Trap  
 PST: Plastic Soap Trap  
 PST: Plastic Snap Trap

**Rodent Species**  
 HM: House Mouse  
 WFH: White-Footed Mouse  
 NR: Norway Rat  
 RR: Roof Rat

**Rodent Age**  
 J: Juvenile  
 SA: Sub-Adult  
 A: Adult

**Rodent Sex**  
 M: Male  
 F: Female

**IPM - permanent residents. Find room/floor connections & voids**  
 WFH: seasonal intruder. Consider exterior entry points  
 Juveniles travel together and climb out for food from the nest  
 If catching juveniles, note that reproductive female present  
 HM, NR, RR: reproductive at 2-3 months, reproduce monthly  
 RR, NR, A: F: reproductive at 2.5+ months, several litters per year

### German



### Brown-Banded



### Oriental



### American



### Oriental

### German



### American

### Brown-Banded



University of Nebraska Department of Entomology

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### Target Pest Influences Plan

**Which roach prefers food spillage?**  
German cockroach

**Which roach prefers pipes/drains?**  
American cockroach

**Which roach doesn't care?!**  
Brown-Banded Cockroach

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### What pest is present?

**Roaches:**  
Grooved  
Blunt ends

**Rodents:**  
Smooth  
Hairs  
Pinched ends

### Insights from Life Stage

**adult male:**  
exterior entry point

**pup:**  
nearby indoor nest

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### Insights from Life Stage

**Adult**

**Late Instar Nymph**

**German Roach Nymph**

### Find Conducive Conditions

**Food**

**Water**

**Harborage**



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### Train yourself to see pest evidence

droppings  
cast skins  
pathways  
tracks  
odor  
critters!

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## Inspection vs Monitoring

<p><b>inspection</b> moment in time</p> 	<p><b>monitoring</b> record of time</p> 
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## Monitoring & Record Keeping



**A record of events over a period of time  
Captures what happened in your absence  
Exploits cryptic pest behavior**

## Identify Structural Issues

**Deficiencies can offer pest harborage**



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## Identify Roach Entry Points




**enter 1.6 mm opening  
harbor in 4.8 mm opening**

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## Identify Mouse Entry Points

**Based on size of rodent skull.  
Rodent bodies are flexible...**




**Mice**  
gaps > 1/4"  
openings > 3/8"

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## Identify Rat Entry Points

**Norway Rat**



**gaps > 1/2"      openings > 3/4"**


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Common Name	Scientific name	Maximum opening size/mesh size	Reference
Biting midges	Ceratopogonidae	0.403 mm – 30 mesh	APFAB, 2009
Chowee skipper	Phaethon eximius	0.393 mm – 32 mesh	Stebing, 1975*
Cockroaches	Blattella germanica	1.64 mm – 12 mesh	Cutler, 1964**
Cotton aphid	Aphis gossypii	0.341 mm – 50 mesh	Barkis & Paine, 1991*
Fruit flies	Drosophila spp.	3.12 mm – 10 mesh	NPS, 2006
Honeybees	Apis spp.	2.00 mm – 7 mesh	NPS, 2006
House flies	Musca domestica	2.03 mm – 10 mesh	Block, 1942
Household	Arabis sp.	1.02 mm – 18 mesh	Wesley & Howell, 1954; Block, 1946
Household	Asphondylia quadrimaculata	1.38 mm – 14 mesh	Block, 1944
Household	Culex quinquefasciatus	0.293 mm – 32 mesh	Stebing, 1975*
Household	Aedes albopictus	0.293 mm – 32 mesh	APFAB, 2009
Household	Psychodidae	0.293 mm – 32 mesh	Stebing, 1975*
Household	Phlebotomus	0.610 mm – 30 mesh	Turkey, 2008*
Household	Phlebotomus	0.662 mm – 28 mesh	Grice et al., 1996*
Household	Phlebotomus	0.192 mm – 80 mesh	Barkis & Paine, 1991*
Household	Phlebotomus	0.205 mm – 7 mesh	NPS, 2006
Household	Phlebotomus	1.6 mm	Town & Marsh, 1997
Household	Phlebotomus	30.8 mm (2 1/2")	Town & Marsh, 1997
Household	Phlebotomus	19.1 mm (0.75")	Town & Marsh, 1997
Household	Phlebotomus	8 mm (0.25")	Town & Marsh, 1997
Household	Phlebotomus	1.9 mm (0.075")	Town & Marsh, 1997
Household	Phlebotomus	13 mm (0.5")	Town & Marsh, 1997
Household	Phlebotomus	13 mm (0.5")	Town & Marsh, 1997

\* Studies conducted with an unobstructed nominal gap size. These were matched with the closest Tyler mesh size. All other studies selected specifically to measure mesh sizes. These were matched with approximate gap sizes. Mesh opening sizes are nominal, i.e., not diagonal.

\*\* Study performed to general buildings for simplicity, not maximum opening for access, which is likely smaller.

Geiger & Cox. 2012. *Pest Prevention by Design*. Authoritative Guidelines for Designing Pests Out of Structures. San Francisco Department of the Environment, San Francisco, CA. 89 pp.



**Exterior Inspection Form Instructions**

The goal of the Exclusion Inspection Form is to help you find and document openings that could allow pest entry into a building. This form applies to commercial and residential buildings.

**Instructions:** The instructions below will help you complete a thorough inspection.

- Plan a starting point.** Typically, a front door or main entrance is a good place to start.
- Right to Left Head Scan.** The best way to scan all parts of a building is to follow the walk-in direction, and if your building has an air or exhaust duct, your inspection is complete when you have gone around the entire building and set up back at your starting point.
- Stay in Contact.** During your inspection, you must be close enough to the building to touch it at all times. This angle means you are looking at the top of exclusion openings.
- Look From Every Angle.** As you move along the wall, look up and down for openings. You might have to get low to check for openings at the sill plate before the foundation meets the siding or other hard to see areas. Remember that most pests are crawling at ground level and have a difficult perspective that you.

**Pay Special Attention.** Common areas of pest entry include:


- Water down drains, between double doors, loading docks
- Oil Pan gaps between construction materials
- Weather strips on wire screens, long holes, water damage
- Roof Line soffits, water damage at gutters

**Test Openings.** Pests can enter through openings of different sizes. During your inspection you'll want to record the size of the largest animal that can pass through. Size references are listed on the form (e.g., 1/8" business card width, mouse 1/2" square), and 1/4" Equine, 2 1/2" mouse, 4" (gingerbread). This information will help you decide what type of exclusion material and installation is best.

**Record Pest Observations.** Look for signs, pest evidence and conditions conducive to pest food, water and shelter. Openings near "conducive conditions" are a higher exclusion priority.

**Record on a Map.** A facility diagram, a single map of the building footprint, a site map or a block diagram map are necessary to record where openings were found. If no official map is available, see the form on the back of this page to draw one. Each time you identify an opening, it should be recorded on the map.


**Preventive Exclusion.** After completing your inspection, you will want to prioritize which openings are critical for exclusion. It is possible that your budget will allow you to seal openings at once, if an exclusion which prevents pest entry to other pest entry. Check map for openings closed to ensure of food, water and shelter, areas with easy access to the building (e.g., loading docks) or where you observed pest evidence.



**Sketch of Property**

Sketch the layout (outlines) of the building to indicate the location of exclusion holes, pest activity, conducive conditions and other features.

Include North




signed & dated

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## Largest Permissible Pest




**Insect**



**Raccoon**



**Mouse**



**Rat**

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Site Name: \_\_\_\_\_ Inspector: \_\_\_\_\_ Building Type: Attached Independent

Address: \_\_\_\_\_ Site Contact: \_\_\_\_\_ Building Use: \_\_\_\_\_

Date: \_\_\_\_\_

For each opening, complete all fields and record the location on a map with the corresponding number

#	Location	Where is opening?	Type	Cause of opening	Pest Evidence	Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						



**Pest Signs**

Insect: 1/8" (business card)

Mouse: 3/4" (quarter)

Raccoon: 4" (gingerbread)

**Door Type**

Single (S)

Double (D)

Roll-up (RU)

Rolling (R)

**Utility Type**

Electrical (E)

Plumbing (P)

Gas (G)

Drain (DR)

Vent (V)

**Cause of Opening**

1. Material failure/degraded

2. Poor design/construction

3. No exclusion attempted

4. Insected material

**Pest Evidence**

Droppings

Feces/urine

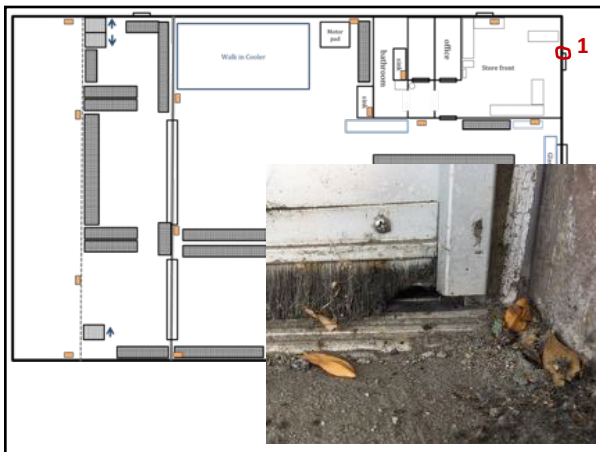
Chew marks

Softwood (chew marks)

Excrement

Live/Dead pest

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## Developing a Program

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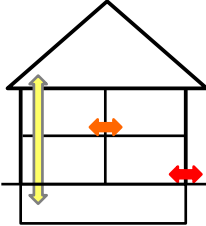
## 2. Prioritization

**Which openings are critical for exclusion?**

- **Primary entry point from exterior**
- **Close to food, water, shelter**
- **Between units & floors**
- **Where you observed pest evidence**

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## Prioritization & Pest Reduction



- 1. trap to reduce the population**
- 2. seal non-preferred entry points**
- 3. seal primary entry point**

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## General Inspection Form

Site Name: \_\_\_\_\_ Address: \_\_\_\_\_ Inspector: \_\_\_\_\_  
 Site Contact: \_\_\_\_\_ Date: \_\_\_\_\_

Category Pest Mgmt Sanitation Exclusion	Priority 1. High 2. Medium 3. Low	Observation Describe the issue and how it contributes to pest population	Location (provide details for staff to find the issue)	Recommendation Provide a solution to the problem you observed. What should the client do?	Image Number

**Categorize**
**Observe**
**RECOMMEND**  
**Prioritize**
**Locate**

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## General Inspection Form

Category	Priority	Observation	Location	Recommendation
Exclusion	1. High	A large gap was noted under the door to the walk-in cooler. Insect monitors and rodent traps were lacking. A few old insect monitors were present (ongoing)	Storage area/walk-in cooler	Construction to add a saddle may be needed to address this issue, as well as a pest proof door sweep. Insect monitors and rodent traps are needed for early detection and rapid response to pest problems.
Pest Mgmt	1. High	Cockroach gel bait applied in excess above food preparation surface. Pest strips are used illegally, with new strips added this quarter (ongoing)	Back counter	Cockroach bait should be applied in small placements, not large globs that could contaminate food preparation surfaces. Pest strips should not be used where food is stored due to the potential for contamination.
Pest Mgmt	1. High	Floor drains are clogged with solid material from spillage.	Throughout	Drains need to be cleaned to remove dry debris, then flushed regularly with water.
Sanitation	1. High	A broken floor tile with standing water was noted.	Dishwash room	The floor tile should be repaired or replaced to eliminate pest harborage.
Exclusion	2. Medium	Spilled, decaying food items were observed on the floor (ongoing issue)	Sanitary	Daily sanitation should remove spilled food items, especially behind equipment legs.
Sanitation	2. Medium	A rolled up floor mat has been under the equipment in the sanitary since February 2015.	Sanitary	Roll up mats provide pest harborage and should be discarded if not in use.
Sanitation	2. Medium	An old electrical outlet opening provides a pathway for pest movement into the wall void.	Dishwash room, next to hot water heater	The opening to the wall void should be closed, likely requiring construction to seal the gap.
Exclusion	3. Low			

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## Developing a Program

- 1. Inspection**
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## 3. Material Selection

**Opening size:** what pest can enter?

**Opening type:** utility; construction; door..

**Pest pressure:** actual; potential

**Environment:** high/low use; moisture; salt

**Scope of Service:** pest threshold; pricing

**Expertise of employees**

**Aesthetics of work**

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**Supplies: PCT Articles**

**Wildlife Exclusion Techniques that Work**  
 Scott McNeely, Sept 2008

**Tools of the Trade for Exclusion Services**  
 Xeluder Rodent & Pest Defense, July 2017

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**National Wildlife Control Operators**

**Exclusion**  
**Module 6 Exclusion**

**Learning Objectives**

1. Identify common ways that wildlife enter structures and surrounding areas.
2. Explain how to determine whether an opening is being used by wildlife.
3. Give examples of manufactured items used for excluding wildlife.
4. Know techniques that should be avoided.

[nwco.net/training-modules/exclusion/](http://nwco.net/training-modules/exclusion/)

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**Considerations**  
 Environment & pest pressure influence  
 product selection and prioritization



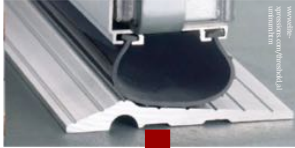

suburban library  
front door





urban restaurant  
alley door

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**Considerations: Function**  
 Weatherization is *not* rodent exclusion

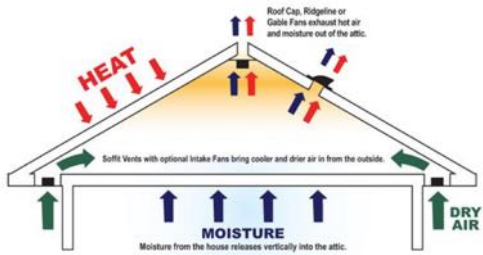
**Rodents overcome weatherization materials:  
 chew, push, climb & work together**

**Considerations**  
 Aesthetics of performed work



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**Considerations: Permeability**  
 Some spaces need to "breathe" to avoid  
 moisture problems



Roof Cap, Ridge/Vent or Gable Fans exhaust hot air and moisture out of the attic.

HEAT

SOFT VENTS WITH OPTIONAL INTAKE FANS BRING COOLER AND DRIER AIR IN FROM THE OUTSIDE.

MOISTURE


Moisture from the house releases vertically into the attic.

DRY AIR

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**Considerations: Permeability**  
**What is it?**  
**What is its function?**



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**Weep Hole Solutions**




**Xeluder Mesh**

**Screens**

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**FYI - Not Exclusion**



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**Umm.. Also Not Exclusion**



Jerry Quinlan, BCE

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**Developing a Program**

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**Sanitation**



treat the problem  
not the symptom

## Record & Remove Pest Evidence

**Verifies treatment efficacy  
Looks good to the customer!**




[www.cdc.gov/rodents/cleaning](http://www.cdc.gov/rodents/cleaning)  
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## Beginner-Level Exclusion

**Less than 1 inch opening: any technician**



- metal mesh fibers
- elastomeric sealants
- escutcheon plates

**Supplies:**

- gloves, scissors, probe, brush/vacuum
- caulk gun, rags

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## Metal Mesh Fibers

<https://buyexcluder.com/>  
**Stainless steel metal mesh fibers are  
abrasive for chewing rodents, do not rust**

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## Selecting a Sealant

Recommendations for Selecting and Using Caulks and Sealants  
 in Pest Management Operations  
 Bobby Cortique, RMC Pest Management Consulting  
 Richmond, IN

The joint caulk and sealant are sometimes used interchangeably, but they are actually two different things. Caulks or sealants are used to seal openings in buildings. The correct material must be selected for the particular hole or opening and then applied in the best method of pest control. In fact, ideally, all holes of any size should be sealed to exclude not only rodents, but invading insects as well.

But what do we actually mean when we advise our clients (or perform the work ourselves) to repair the holes, cracks and crevices of buildings? "Plugging a hole" to keep pests out may be a menial job, but it is important that it be done correctly. Too often, this seemingly simple task is not given the attention it deserves.

"Pest-proofing" small holes ranges from the simple stuffing of some metal mesh into a hole to a more detailed process of selecting a specific sealant for the particular hole or opening and then applying the sealant in a manner that offers long-term protection. This column addresses pest-proofing small holes from simple to the more elaborate situations to keep rodents (and insect) pests out in a manner that offers cost-effective permanency for your clients.

**CAULKS VS. SEALANTS:** The terms "caulk" and "sealant" are sometimes used interchangeably, but they are actually two different materials. Both caulk and sealant have their place in structural repairs (and thus in pest-proofing). Unfortunately, it is common to hear from the lay public and pest professionals alike the generic phrase of "caulking up" holes and cracks. But for persons involved in building maintenance (e.g.,

Material*	How Used	Application	Joint Expansion/Contraction	Temperature Range	Shrinkage/Expansion	Durability
Oil Based	2%	non-pneum.	0.25 in.	-20 to 200°F (-4 to 392°F)	40% (1)	100
Butyl	7-10%	non-pneum.	1.0 in.	-20 to 200°F (-4 to 392°F)	40% (1)	100
Latex	2%	neut.	5.0 in.	40 to 200°F (104 to 392°F)	40% (1)	100
Acrylic Latex	2%	neut.	1.25 in.	-20 to 200°F (-4 to 392°F)	40% (1)	100
Urethane	10%	neut.	30.0 in.	-20 to 200°F (-4 to 392°F)	40% (1)	100

**Choosing caulks and sealants**

Those involved in attempting to seal joints in buildings need to know how to choose the right caulk or sealant for each situation. The choice of material might not seem so important because any of the materials will fill the hole in a gap. The problem is how long the caulk or sealant will remain intact. Choosing the material for each situation will help ensure a long-lasting repair. The following factors should be considered when choosing a caulk or sealant:

- Amount of movement expected at the joint. Generally, less movement is expected at a joint between the same materials (e.g., wood-to-wood) than between different materials (e.g., wood-to-metal). One solution is to use a caulk or sealant that is specifically designed for wood-to-metal joints.
- Compatibility between the surface and the caulk/sealant material. Some surfaces are inherently difficult to apply caulk/sealant to (e.g., PVC, treated wood, etc.).
- Life expectancy of the caulk/sealant (e.g., resistance to rodents, insect, rodents, high temperature and UV light).
- Surface and application temperatures range.
- Appearance (especially important).
- Ease of handling and application.

\*These characteristics for the common caulks and sealants are summarized in Table 1, page 2.

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## "Pest-Proofing Small Holes"



**includes  
product  
suggestions**

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## Escutcheon Plates

**can be moved: must be sealed to wall**




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### Intermediate-Level Exclusion

1 to 4 inch openings; doors: advanced tech

- hardware cloth
- door sweeps & astragal (vertical) seals

**Supplies:**

- gloves, drill, tin snips, fasteners, level, measuring tape, straight edge, brush/vacuum...

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### Hardware Cloth

exclude rats  
(19 gauge)



1/2" x 1/2"

exclude mice  
(24 gauge)



1/4" x 1/4"

**Woven, galvanized hardware cloth is best**

**Fasteners and substrate matter!**


- Staple guns may not be effective
- Use hex-head screws with washers
- Don't give them an edges/corners

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### Consideration


Ventilator grills must not impede airflow

- 18-gauge, 1/2 inch mesh, galvanized expanded metal
- 16-gauge, 1/2 inch mesh, galvanized wire cloth



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### Door Sweeps



**High Density Brush Sweep**

- prevents crawling insects
- can prevent mice

**Rubber-Encased Steel Fabric**

- prevents insects & rodents

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### Considerations


Brush sweeps can fail under high pressure



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### Considerations

Correct installation critical for all types



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### Garage Door Compression Seal



**CLUDER**  
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### Advanced-Level Exclusion

**4+ inch openings, soffits/roofs, chimneys:  
exclusion crew w/ construction expertise**

- masonry & associated tools/supplies
- sheet metal & associated tools/supplies
- carpentry & associated tools/supplies


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### Concrete Hollow Block



<https://www.cluder.com/>  
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### Galvanized Sheet Metal



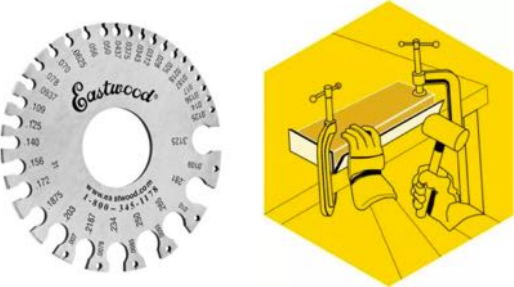
**22 gauge kink plate  
12" tall on exterior**

**24 gauge or thicker for  
wall or pipe barrier**

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### Considerations


**Sheet metal gauge and bending break**



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### Special Situations


**foundation barriers and burrowing rodents**



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### Vegetation Free Zones

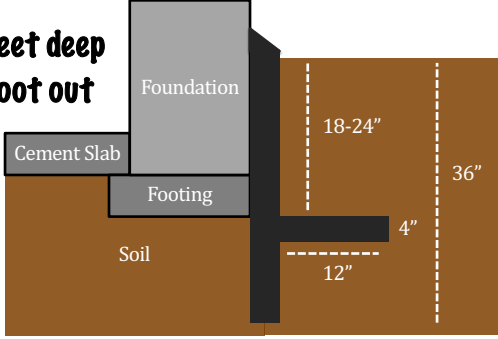
~1 inch diameter stone  
2 foot wide band  
6 inches deep



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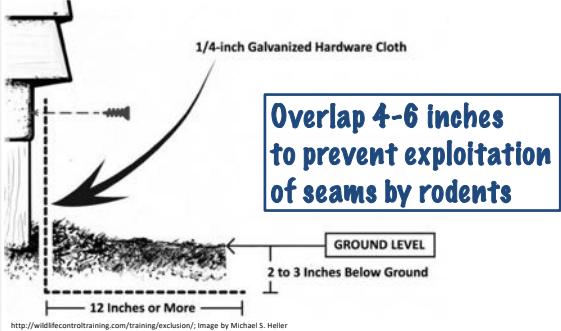
### Curtain Wall: Cement/Metal

3 feet deep  
1 foot out



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### Curtain Wall: Hardware Cloth



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### Coarse Stainless Steel Mesh




1 or 2-sided  
Water permeable

NYC tree pit with rodent burrows

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### Floor Drains

often overlooked as source of pests  
water use can influence selection



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### Don't Forget Pest Bridges!



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## Human Behavior Always Wins..

Torn screens, open windows and doors allow pest entry



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## Developing a Program

1. Inspection
2. Prioritization
3. Tool & Material Selection
4. Implementation
5. Evaluation

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## 5. Evaluation/Documentation

What did you do and where?

Was your treatment effective?

What do you need to do in the future?

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## Opportunities in Exclusion

pest exclusion can be routine service

- annual inspection at least 2x/year
  - spring to assess winter damage
  - fall to prevent entry
- identify new entry points
- repair/replace materials
- indoor monitors for verification

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1. Communicate with client
2. Map the location (or use existing map)
3. Systematic, thorough inspection
4. Identify openings
5. Record observations
6. Evaluate pest pressure & activity
7. Prioritize exclusion needs
8. Select appropriate materials/plan
9. Clean area to remove pest evidence
10. Perform exclusion
11. Monitor pest activity
12. Monitor exclusion material
13. Communicate with client

## SCOPE Website: Start at "nysipm.cornell.edu" "Community" -> "Homes and Other Buildings"





General Resources

Material Selection

Tool Selection

Conducive Conditions

Inspection Forms

**The New York State IPM Program**

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**SCOPE**  
SCIENTIFIC COALITION ON PEST EXCLUSION

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