

# COMMENSAL RODENTS — BIOLOGY, POPULATION DYNAMICS & IPM

## Integrated Pest Management Curriculum for Norway Rats, Roof Rats and House Mice

### Curriculum Outline

Time Required: 4 hours (11:00 am to 3:00 pm: 3 ½ hours of class time and ½ hour for lunch)

Suggested Class size: 15 to 20 participants

### Objectives:

1. Learn about the biology and behavioral ecology of commensal rodents (roof rats, Norway rats and house mice)
2. Understand basic population dynamics of commensal rodents
3. Understand how biology and population dynamics affect management
4. Learn about effective habitat manipulation, horticultural, mechanical, and chemical management techniques, their advantages and limitations, and explore examples of appropriate uses for each technique
5. Use group exercises to gain more insight into evaluating management alternatives for a particular site

### Synopsis of Class

- A. Lecture and Discussion
  1. Introduction, page 3  
Define terms; discuss public health and quality of life concerns.
  2. Biology and Behavioral Ecology, page 3  
Discuss the differences in biology of commensal rodents. Describe sensory abilities, physical abilities, feeding habits and reproduction. Discuss how and why commensal rodent populations grow and decline.
  3. Management Informed by Biology, page 6  
Discuss components of an IPM program including monitoring techniques. Emphasize the relationship between successful management and an understanding of biology, behavior and population dynamics.
- B. Hands-on Exercise, page 18  
IPM Plan for a Berkeley Warehouse  
Students read notes from an inspection and sanitation report on the warehouse and answer questions together in small groups about how to manage the commensal rodents at the site. Each group presents its findings to the rest of the class.
- C. Class exam for the Structural Pest Control Board (SPCB), page 25  
Students take a short exam to qualify for continuing education credits from the SPCB.

### Materials for Class

- Supplies for group exercise, page 18
  - Instructions and inspection notes
  - Warehouse diagram
- Handouts (included starting on page 27)

1. Important Biological Facts about the Roof Rat (*Rattus rattus*), the Norway Rat (*Rattus norvegicus*), and the House mouse (*Mus musculus*)
  2. Summary of Commensal Rodent Management Techniques Most Compatible with an IPM Program
  3. Rodent Trap Notes
- Selected Resources (see page 35)
  - Photographs of commensal rodents, their habitat, behavior and conditions conducive to their presences
  - Monitoring tools for display:
    - Flashlight
    - Hand lens
    - Pocket ruler (6" length)
    - Plastic Ziploc bag and vial for specimens
    - Tweezers for collecting specimens
    - Pen, pencil, clipboard, notepad, monitoring forms
  - Products used in management for display:
    - Vacuum with HEPA filter
    - Exclusion materials such as sheet metal, hardware cloth, expandable metal net, knitted copper mesh, spackle, various kinds of caulk, various kinds of door stops, door sweeps, drywall corner
    - Exclusion tools such as tape measure, tin snips, hammer, screw drivers, pliers, utility knife, scissors, small pry bar, assorted nails and screws
    - Traps—snap, snap with expanded trigger, live single catch, live multiple catch
    - Tamper-resistant bait stations

# Integrated Pest Management Curriculum for Commensal Rodents

## Lesson Plan

**Note: Throughout the presentation, it is important to engage the audience with questions that will elicit information about their experiences with commensal rodents and especially about their most difficult situations.**

### 1. Introduction

#### Define terms for class:

- Zoonosis: an infection or infectious disease transmissible under natural conditions from vertebrate animals to humans
- Transmission: any mechanism, direct or indirect, by which an infectious agent is spread from any source to a person or animal
- Zoonotic Vector: an animal that transmits (carries) a pathogen (disease organism) to humans
- Zoonotic Pest: an animal perceived as detrimental to humans
- Commensal Pests/Vectors: species of “wildlife” that have adapted to, and depend in various degrees on, the human built environment (buildings, rubbish heaps, sewers, etc.) as a source for food, water, and/or shelter

#### Discuss issues with commensal rodents and the human built environment

- a. Structures provide harborage indoors
  - i. Protection from the elements and predators
  - ii. A place to give birth and raise young
- b. Structures often provide food/water indoors
  - i. Human living quarters
  - ii. Office spaces
  - iii. Restaurants
  - iv. Food warehouses
  - v. Animal quarters
- c. Outdoor attributes
  - i. Exposed garbage provides food
  - ii. Cracked foundations, rubbish heaps, etc. provide shelter
  - iii. Clutter, sewers, landscaping, etc. provide access routes

#### Discuss public health and quality of life concerns

- a. Cause nuisance and aesthetic problems
- b. Eat and contaminate foodstuffs
- c. Damage structures and material goods
- d. Cause suffering from psychological stress, bites, and disease, including asthma

People are exposed to rodent allergens most commonly through inhalation, either by direct exposure (e.g., mouse allergen from a pillow) or indirect exposure (e.g. mouse allergen on someone else’s clothing).

### 2. Biology and Behavioral Ecology

#### Scientific classification: Class Mammalia, Order Rodentia

- Important commensal species
  - Norway Rat (*Rattus norvegicus*)
  - Roof Rat (*Rattus rattus*)

4. House Mouse (*Mus musculus*)  
Occasionally Commensal Field Mice  
Deer Mouse (*Peromyscus maniculatus*)  
White-footed Mouse (*Peromyscus leucopus*)

### **Understanding rodent behavioral ecology**

#### **Norway Rat**

- Common urban and rural rat found throughout U.S.
- Largest of the commensal rats in the U.S. (105 to 600 g)
- Primarily nocturnal
- Burrows extensively
- Food—prefers cereal and other grains, but omnivorous (will eat household garbage)
- Leaves odor trails of urine, feces and other secretions; leave hair, scales, dander, partially consumed food, and pheromone laden dust (allergenic)

#### **Roof Rat**

- Called the roof rat, ship rat, or black rat
- Occurs worldwide, abundant in ports and contiguous areas
- Smaller, thin/streamlined appearance (80 to 350 g)
- Primarily nocturnal
- Highly arboreal (climber), burrows only infrequently
- Food—prefers fruit, nuts, grains and invertebrates (e.g. snails and insects), but is omnivorous
- Leaves odor trails of urine, feces and other secretions; leave hair, scales, dander, partially consumed food, and pheromone laden dust (allergenic)

#### **House Mouse**

- More widely distributed worldwide than Norway and roof rats
- Much smaller than either rat species (12 to 25 g)
- Primarily nocturnal, but unpredictable
- Occasionally burrows, good climber
- Food—prefers cereal, grains, and seeds, but omnivorous
- Leaves odor trails of urine, feces and other secretions; leave hair, scales, dander, partially consumed food, and pheromone laden dust (allergenic)

### **Behavioral ecology issues with commensal rodents**

- Much opportunity to interact with humans
- Very mobile and found nearly everywhere
- May congregate in large numbers
- Small size: gain entry to human and/or domestic animal living spaces and their initial utilization of human structures may not be noticed
- Relatively secretive behavior: active nocturnally or at dusk and dawn and they use remote niches and/or our belongings to hide
- Persistent interlopers

### **Characteristics of Commensal Rodents**

- Active mostly after dark, but are adaptable if warranted by circumstances; indoor mice are generally nocturnal but less predictable than rats
- Prefer to travel along, and in contact with, vertical surfaces rather than in the open; wary of crossing open spaces that provide no cover
- Form runs

- Range of movements depend largely on location between food resources and suitable harborage

Under stable conditions their movement is limited. A Norway rat will move within a diameter of 100 to 150 ft., a roof rat, 45 to 150 ft., and a house mouse, 10 to 30 ft. This range may expand when conditions are unstable or changes, such as a construction site. They may also expand their range in protected areas such as in sewers, in passages between buildings, and under groundcovers and during seasonal or climatic change

### **Avoidance and exploration**

Neophobia—fear of new objects

- Norway and roof rats tend to be extremely wary (though temporarily—for a few hours to a few days) of new objects in an otherwise stable environment
- Mice readily investigate new objects and changes in their environment

### **Physical abilities**

- Access holes & gaps
  - a. Norway and roof rats: ½” gaps or cracks and ¾” diameter holes
  - b. House mouse: ¼” gaps or cracks and ½” diameter holes
  - c. As a ‘rule of thumb’, adult rats can pass through holes the size of a quarter; adult mice through the size of a dime
- Jumping
  - a. Vertical jump from a standstill
    - Norway 2 ft
    - Roof 2 or more ft
    - House mouse 1 ft
  - b. Vertical jump from a running start and banking
    - Norway 3 ft
    - Roof 4 ft
    - House mouse 2 ft
- Climbing: Roof rats are excellent climbers, Norway rats do not climb as readily or as well as roof rats and house mice are good climbers  
Roof rats can easily run on narrow gauge, loose wires or ropes
- Miscellaneous: Norway rats can reach 13” above a flat surface and both Norway and roof rats can swim up through the trap in a toilet

### **Feeding habits**

- Omnivorous (eat both plant and animal matter)  
Preference is based largely on what is readily available. Under lean conditions, they may be attracted to unusual items such as the fat in bars of soap. Given a choice, all can be attracted to cereal grains and seeds, and all are capable of selecting a nutritious diet.
- Roof rats:
  - Can be erratic eaters
  - Fruits, berries, nuts, seeds
  - Frequently associated with avocado and citrus trees
  - Snails, insects
  - Dog and cat kibble
- Norway rats
  - Steady eaters

- Cereal grains, seeds, nuts
- Meat and fish
- Commonly forage in garbage
- House mice
  - Nibblers
  - Cereal grains, seeds (e.g., birdseed)
  - Will eat many items including insects, flour, snack foods, candy
  - Do not commonly forage in garbage cans, but will take advantage of indoor waste cans
- Daily water requirement depends on
  - Diet—high protein or dry diet increases need, succulent food decreases need
  - Species—Norway rats need more free water than roof rats or house mice; house mice are especially good at using metabolic water
  - Available water will attract all 3 species

### **Reproduction, development, and mortality**

- Early sexual maturity
  - Rats: 2-3 mo.
  - Mice: 1-2 mo.
- Short estrus cycle
  - Rats: 5 days
  - Mice 4 days
- Multiple breeding cycles
  - Breed all year long, but decrease with cold or dry seasons
  - Increase in numbers when population size is low
- Short gestation period
  - Rats: 22 days
  - Mice: 19 days
  - Extends when nursing
- Large litter size
  - Rats: 6-12 pups
  - Mice: 4-8 pups
- Postpartum estrus
  - Rats: 2 days
  - Mice: 2-4 days
- Short life span
  - Rats: approximately 1 yr.
  - Mice: less than 1 yr.

## **3. Management Informed by Biology**

### **Shortcomings and errors in vector/pest management**

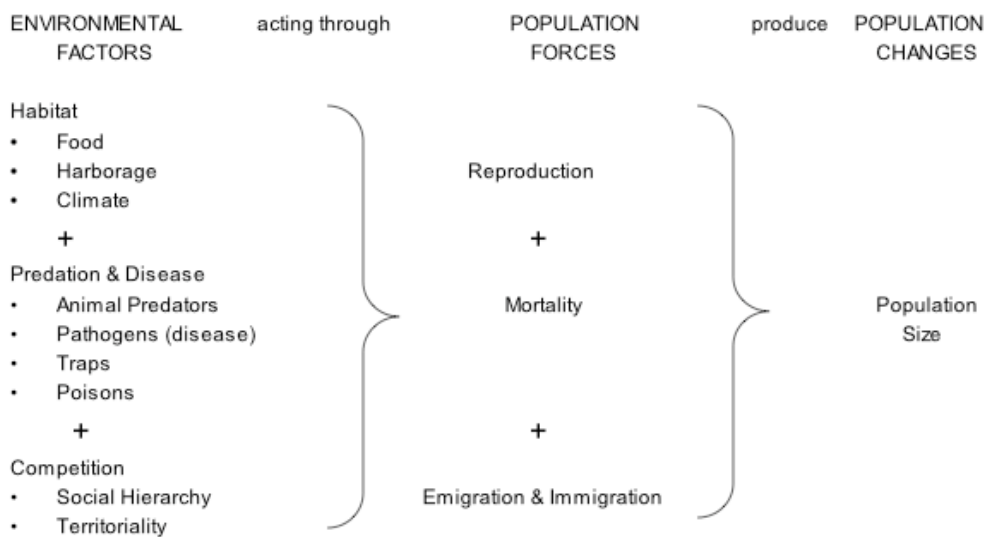
- Lack of eco-literate thinking—the whole system is not taken into account when devising a solution to a pest problem
- Magic bullet syndrome—the belief that there is one quick fix for pest problems
- Deteriorated infrastructure—American Housing Survey (2002), from U.S. Census, 2002
  - ~7 million occupied housing units have physical conditions that contribute to an unhealthful living environment
  - >2 million housing units have severe physical structural problems

- >8.5 million housing units have evidence of commensal rodent infestation

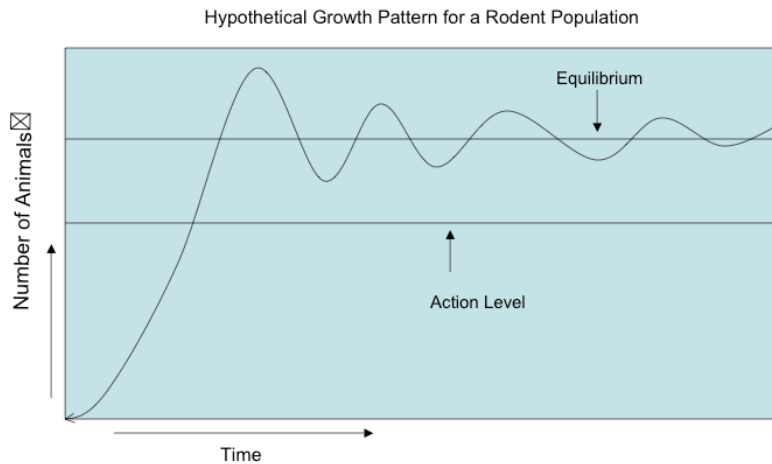
**Population dynamics—how and why populations grow and decline**

- Control mechanisms in animal population growth: Environmental Factors
  - Habitat: Food, harborage, climate
  - Predation and Disease: Animal predators, pathogens (disease), traps, poisons
  - Competition: Social hierarchy, territoriality
- Control mechanisms in animal population growth: Population Forces
  - Reproduction
  - Mortality
  - Emigration and immigration
- Environmental Factors acting through population forces produce population changes:

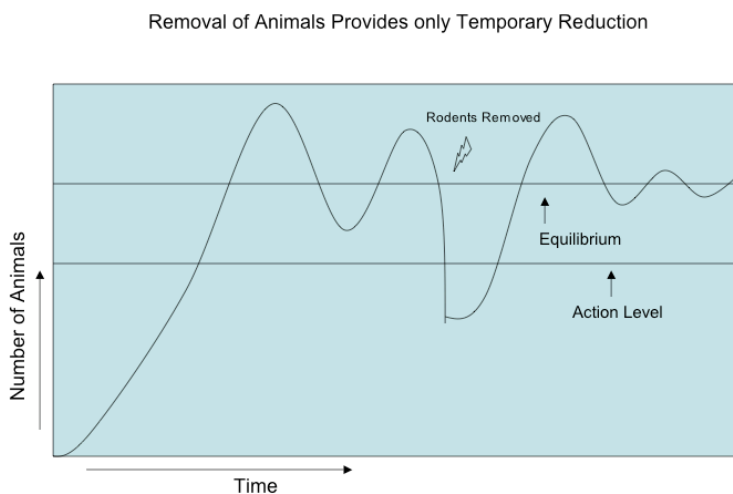
**Control Mechanisms in Animal Populations**



## Hypothetical Growth Curves for Rodent Populations



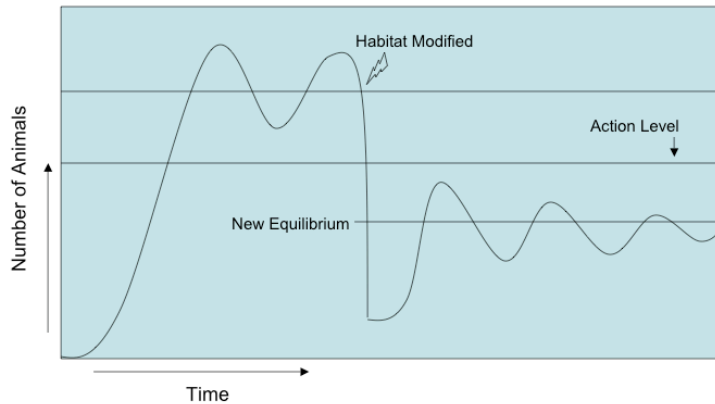
This graph depicts an unchecked population that fluctuates around a point of equilibrium (at “carrying capacity”). The “carrying capacity” of the environment is the number of animals the environment can support. Note that the number of animals the environment can support is above the “action level”. The action level is the population size at which action must be taken to prevent public health, nuisance, or economic damage from occurring.



This graph depicts a temporarily suppressed population. Individual rodents are removed, but because the carrying capacity of the environment is unchanged, the population rebounds to the level that the environment can support.



Modification of Habitat Provides Permanent Reduction of Rodents



This graph depicts a permanently suppressed population. This is the result of modifying the habitat (reducing carrying capacity) to support fewer rodents (e.g. closing holes, removing food). This affects the whole population, including breeding members. There is now a new equilibrium that is below the level of concern, (below the “tolerance limit”).

**We need a paradigm shift in pest control: from one of killing pests to one of preventing pests and thinking in terms of full-cost accounting**

- To quote Robert Snetsinger in *The Ratcatcher’s Child* (1983): If we are to “move from a system of pest killing to one of pest prevention”, then the role of the pest controller must be to
  - Work with city planners to design “pest free cities”
  - Help architects and engineers design buildings without pest harborage and movement routes
  - Assist designers of furniture and equipment to eliminate havens suitable for various pests
  - Help landscapers create gardens and parks without supporting pest infestation
  - Work with whomever necessary to create changes in human attitudes and behavior that discourage pests
- Think of management in the context of the behavior and ecology of the target species
- Think of management in terms of the environment in which the target species is active
- Consider the periodic changes that occur in that environment
- Always maintain safety for people, non-target species, and the environment

### **Defining Integrated Pest Management**

A decision-making process in which all *necessary appropriate* treatments are brought to bear on a Zoonotic vector/pest problem with the goal of providing a remedy that is the most

- Effective
- Safe
- Economical
- Sustainable

**Remember that reduction of carrying capacity of the environment is *key*.** To reduce the carrying capacity, you must rely on a number of interventions and emphasize habitat modification.

### **Summary of Operational Components of the IPM Strategy**

- Inspection and monitoring
- Tolerance level=that level of a vector/pest population that can be correlated with “injury” sufficient to warrant intervention; action level (action threshold)=the point at which you take action to avoid exceeding the tolerance level
- Interventions (treatments, corrective actions) = actions taken to reduce the size of a vector/pest population and/or to prevent or reduce damage that can be attributed to it
- Evaluation of the IPM program and the pest problem to determine if the interventions are working

### **IPM Components: Inspection and monitoring**

- You must have the right tools to do an inspection properly. A minimal kit should include
  - Flashlight
  - Hand lens
  - Pocket ruler (6” length)
  - Plastic Ziploc bag and vial for specimens
  - Tweezers for collecting specimens
  - Pen and pencil, notepad, clipboard and monitoring or inspection forms
  - Traps may be needed to collect pest specimens for accurate identification
- Investigate conducive conditions: this may involve detective work and “connecting the dots”
- Identify natural enemies indoors and outdoors (cats, dogs, owls, other birds of prey)—don’t harm species that are your allies
- Identify potential problematic species (e.g. cat and dog food and other pet kibble can provide food for rodents)

### **IPM Components: Tolerance level**

What is tolerable? Perceived “injury” can be aesthetic/nuisance, economic, or public health. The tolerance level will vary depending on the customer and the situation, so it is important to carefully assess the needs of the customer and the limitations of the situation.

## **IPM Components: Treatments (interventions, corrective actions)**

### **Education**

#### **Legal/regulatory actions**

#### **Habitat modification**

#### **Biological controls**

#### **Mechanical controls**

#### **Horticultural controls**

#### **Chemical controls**

**Electronic/electromagnetic** (Note: There is no scientific evidence to show these devices work and they have no role in an IPM program)

### **Treatment/Intervention Details**

**Education**—to change human behavior to coincide with the principles and practices of IPM.

“Education does not mean teaching people what they do not know. It means teaching them to behave as they do not behave.” —John Ruskin (19<sup>th</sup> Century)

Educate the customer (and/or community), regarding rodent biology and behavior, and explain actions the customer can take to discourage rodent presence and to interfere with rodent survival. ***This is the single most important intervention.***

Customer education is vital to the success of any rodent IPM program. It must be given top priority and the components must be designed carefully. The information and educational approach will differ depending on who is the target audience, e.g. printed materials will be ineffective for people who do not or cannot read. Consider the whole range of media—slide lectures, demonstrations, workshops, one-on-one on-site consultation, videos, email, newsletters, pamphlets, posters—and choose those best suited to the situation.

**Legal/Regulatory**=the development, promotion, and enforcement of regulatory codes, ordinances, and laws that relate to rodent management

Inform customers about codes, ordinances, and laws pertaining to specific pest problems. This is a form of education that keeps customers aware of their legal rights, or of liabilities that could motivate them toward compliance.

In some cases, it may be necessary to inform regulators of client practices that endanger the health and welfare of people, domestic animals, or the environment.

### **Habitat Modification**

This is the reduction/elimination of those elements in the environment that enable rodent populations to find food and harborage.

- **Sanitation**=all actions regarding management of solid wastes indoors and outdoors
  - Store all garbage in rodent-proof (or at least rodent-resistant) containers and make certain all indoor garbage is moved to

outdoor storage each evening (no overnight garbage indoors).

- Long-term storage should be outside. Containers should prevent rodent access, e.g., wheeled heavy-duty plastic containers with flip-tops, galvanized cans with dome tops and spring-loaded doors.
  - Be certain that all indoor and outdoor garbage containers are emptied frequently enough to prevent overflowing, and that such containers are thoroughly washed with soap and water no less than every 2 weeks.
  - Never leave pet food exposed (indoors or out) before or after pets eat. You cannot count on pets to keep rodents away.
  - Promptly clean up spilled birdseed around feeders
  - Recyclables should be cleaned before storage. Indoor storage is temporary and should be removed at least once a week. Long-term storage should be outside, but ideally collection should be once a week.
- **Housekeeping and storage practices**=cleaning and storage practices that result in conditions that are *not* conducive for pest/vector species

**Areas should be clean, dry, and well maintained.**

- Rodent droppings and urine-contaminated dust and debris should be removed with a HEPA-filtering vacuum cleaner; this is especially important in living quarters.
  - Hard surfaces that have been contaminated with rodent urine and/or droppings should be washed with soap and hot water.
  - General food materials (snacks, groceries, etc.) should be stored in rodent proof (or rodent resistant) containers, e.g., glass jars with screw-on lids with rubber gaskets, metal or plastic containers with tight-fitting lids. This includes pet kibble, grass seed, and birdseed.
  - Very large containers of food (e.g., cartons of breakfast cereal) should be stored on shelving beginning at least 18” above the floor and in narrow rows (6ft wide or less). Shelving should be kept at least 18” from walls.
  - Store essential non-food materials and goods on racks or shelving
  - Sort, store, or discard non-essential items (a.k.a. clutter)
- **Exclusion/pest proofing**=physical/structural measures that deny vector/pest access to basic life-supporting resources

Allow class time to look at exclusion tools and materials on display.

- Dimensions of concern for commensal rodents—for rats: holes the diameter of a quarter; for mice: holes the diameter of a dime

- Quality control—work *must* be competently executed so that it is both permanent and neat in appearance. Use only durable materials that are properly suited to the location.
- Close voids, cracks, crevices, wide spaces under doors, gaps in foundations, and other openings.
- Cover air vents with ¼” hardware cloth.
- Seal gaps where pipes, wiring or other conduits pierce a building’s exterior shell. Similarly, seal interior openings that would make it possible to limit rodent movements to particular rooms or areas.
- Weather-strip doors and windows, use metal kick plates, brush/vinyl door sweeps, automatic drop sweeps, and/or raised metal thresholds.
- Make sure all HVAC units are well sealed from rodent access, especially those on the roof.
- Repair underground and basement sewer pipes that are broken.
- Install threaded caps on sewer pipe clean-outs.
- On open floor drains, install grates with small openings (e.g., ¼” holes); similarly, block rodent entry to outdoor drains.
- If a building’s construction is still in the planning stage, encourage or initiate rodent proofing designs (prevention of rodent infestation is always easier to accomplish than post-infestation management).
- **Horticultural Controls**=corrective actions that are concerned with landscape design, re-design, and maintenance that produce conditions *not* conducive to pest/vector species

This includes modifying landscaping elements used by rodents as food (e.g., Algerian ivy, date palms, other fruit and nut trees), harborage (e.g., rock or brush piles, dense foliage/ground cover), travel routes (e.g., long expanses of low, dense ground cover, hedges and other vegetation next to foundation walls), and access routes to buildings (e.g., trees, bushes, and vines touching the structure)

- Thin out or replace dense shrubs and bushes.
- Reduce or remove dense groundcover or replace with less dense varieties or alternative species.
- Break up dense plantings with pathways (pebbled rock at least 6” deep and at least 36” wide recommended), stretches of lawn, or very low groundcover to discourage long rodent runs.
- Regularly trim all lawns and bushes; stay aware of any rodent activity.
- Regularly pick up fallen fruit and nuts outdoors.

- Remove groundcover, grass, weeds, and bushes within 2' of buildings; replace with inspection strips of pebbled rock (at least 2' wide x at least 6" deep).
- Trim tree/shrub branches at least 3' to 6' away from buildings. Trim overhanging branches. Keep vines off building walls.

### **Biological Controls**

This is the use of predators, parasites, or pathogens to help control a vector/pest species.

In the case of commensal rodents, it is unlikely that biological controls can have a significant enough impact on a population to be able to use this strategy as the main focus of an IPM program. However, biological controls are another source of mortality and should be seriously considered.

- Encourage the introduction and conservation of appropriate predators (e.g., peregrine falcons, owls, and snakes) that could reduce (not eliminate) rodent numbers, and would add interesting species diversity to the built environment.
- Cats can “prune” a rodent population but will seldom eliminate it, and in most situations should not be counted on as a deterrent.

**Mechanical Controls**=devices that a target species enters, or walks onto, and/or releases a trigger mechanism that results in the animal being captured dead or alive.

As a supplement to the preceding interventions, place properly sized traps and record their locations on your site plan/sketch. You must be able to easily find all the traps to service them.

*Snap traps* are lethal and relatively humane.

*Live traps* (internal trigger only) are used if the customer prefers, or to collect external or internal parasites or disease organisms from a live specimen, or acquire a full rodent specimen in good condition.

*Glue boards* are quasi-lethal, clearly inhumane and less useful for rats. Their use is generally not recommended.

Monitor traps regularly (at least daily) and keep bait fresh. Rodents generally will not feed on dried or rancid bait. Frequent monitoring keeps the most traps available, and allows removal of malfunctioning ones and repositioning of ineffective ones.

Snap traps and live traps do not need to be cleaned, except to insure proper functioning of the trigger and capture mechanism, and may be more attractive when soiled with rodent odors.

Always use safety equipment including rubber (vinyl, latex) gloves, goggles, a HEPA filter respirator, disposable coveralls, and disposable shoe covering when servicing traps

#### *Setting Traps*

- Set snap traps with the trigger end facing the wall and the edge of the trap flush with the wall. Two or three traps in a row will make it difficult for rodents to jump over them without being caught.
- Expanded triggers can make snap traps more effective.
- Snap traps can also be set parallel to the wall, back to back with their triggers facing away from each other. Live traps can be similarly set, with

their open ends facing away from each other. Set glue boards with the long side touching the wall.

- Nail snap traps to walls, rafters or trees, or wire them to pipes with the trigger projecting into the runway. Live traps, with internal trigger mechanism, can be set/hidden under debris, piles of clutter, etc. and still are functional. Lightweight cardboard glue boards can be wrapped around a pipe (held in place with thin wire ties)
- JT Eaton makes a metal Snap Trap Station that can be used to protect 2 rat traps or 3 mouse traps
- Move objects around to funnel rats into traps. Also use objects to protect traps from non-target species, or place traps (snap or glue) inside large tamper-resistant bait stations or in ready-made snap trap stations, or place traps in areas/rooms inaccessible to non-target species.
- Use plenty of traps, preferably in groups. Trapping intensely for a few days is generally more effective than distributing traps sparsely over a wide area. Think three-dimensionally; experiment to learn what pattern of trap placement works best in each situation. Remember, traps must be positioned so that rodents easily encounter them in their normal activity areas.

### *Baiting Traps*

For bait choices, use foods the rodents are already known to be eating, or try baits that could be highly competitive with the rodents' standard diet including the baits listed below.

- Baits for Norway rats include peanut butter, pieces of hot dog, singed bacon, nutmeats, fresh apple slices.
- Baits for roof rats include nuts, dried fruit, fresh apple or banana slices, candy, marshmallows, raisins, peanut butter.
- Baits for house mice include peanut butter, peanut butter mixed with bacon grease, raisins, gumdrops, chocolate candy.
- Baits that don't stick to the trigger can be tied on with string, dental floss, or very thin wire.

It may be necessary to "pre-bait" traps (snap or live) for a few days to enhance trapping success for rats. Place traps out with bait, but do not set the triggers. Check daily to see if bait is taken and replace. When the take is steady, add a very small amount of fresh bait to the underside of the trigger, and set triggers. Rodents will be likely to manipulate the trigger looking for the bait that they were accustomed to finding and that they can now smell.

### **Chemical Controls**

These are substances or mixtures of substances intended to prevent, destroy, repel, or mitigate a vector/pest.

In general, chemical controls should be used only as a last resort or in some emergency situations. Thus, for most commensal rodent infestations, especially residential, rodenticides usually can and should be avoided altogether.

If the risk of disease is significant, rodenticide bait application could be warranted both indoors and outdoors when combined with more sustainable actions, particularly, intensified habitat manipulation, mechanical, and educational interventions.

Remember, depending on the toxicant used, non-target species (children, pets, domestic animals and wildlife, including rodent predators), can be poisoned from either eating the rodenticide directly (eating exposed bait) or indirectly (i.e., eating a dead rodent containing the rodenticide).

***No rodenticide should be applied unless it has a very effective, readily available antidote (e.g., vitamin K<sub>1</sub> for anticoagulants) that can likely be administered soon enough to save the life of the poisoning victim.***

- Because of the inherent risks of accidental poisoning of non-target species, the rodenticide of choice should be first generation anticoagulant products that kill after multiple, sequential feedings. These products have a relatively wide margin of safety. Examples are warfarin (hydroxycoumarin product) and chlorophacinone (indandione product). Note that diphacinone is of particular concern in accidental poisonings of dogs.
- Warfarin is particularly useful because quality products are well accepted and effective against all 3 commensal rodents. Warfarin has a short biological half life (less than 48 hours) that reduces the probability of secondary poisoning.

*Note:* Where anticoagulant rodenticide resistance is a concern, the resistance can usually be overcome if at least 30 days is allowed to lapse between exposures. In other cases, simply apply good IPM practices; no rodent will be resistant to the resulting lack of food, water, and shelter.

- Carefully follow all label guidelines for the specific rodenticide bait being applied; review all product hazards and use restrictions.
- Typically, place the bait in tamper resistant bait stations that are securely locked and anchored to a heavy or immovable object (indoors—floor, wall, other structural member; outdoors—paving block, fence, etc.).
- Another potential downside to rodenticide applications, especially indoors, is that poisoned rodents may die in inaccessible places and cause odor and fly or other problems (e.g., dermestid beetles, aesthetic issues).

#### Tamper-Resistant Bait Stations

To be “tamper-resistant”, a bait station must be able to withstand intensive investigation by the average dog or 6-year-old child without having the bait exposed. A bait station must

- be fabricated of steel, rigid plastic, or other durable, waterproof material
- have a baffled interior to prevent non-target species from reaching the bait
- have a lid that “locks”
- have a design that allows baits to be secured inside (with rods, wire, etc.)
- be designed to be anchored to a floor, wall, heavy object, or into the soil



### **Ultrasonic Devices and Electromagnetic Devices**

These devices are designed to emit some signal, frequency, or sound that theoretically will frighten or otherwise drive a vector/pest from a target area.

There is no compelling scientific evidence to show that these devices kill or repel rodents (or any other pests) in a dependable manner; thus, such devices have no role in rodent IPM programs.

### **IPM Components: Evaluation**

- Determine the outcome of any of the preceding interventions
- Establish which actions will follow
  - Change of treatments with continued monitoring
  - Termination of treatments with continued monitoring
  - Only monitoring

### **SUMMARY**

Commensal rodents are a ubiquitous problem and remediation is complex. Management should emphasize basic IPM remediation:

- a) Educating customers and the community—this is critical
- b) Keeping living and working spaces clean, dry & low humidity, well maintained
- c) Reducing food, water, shelter and movement/access resources
- d) Exclusion from specific rooms, buildings and other structures
- e) Judiciously applying appropriate pesticide(s) when necessary
- f) Monitoring vector/pest species, emerging problems, and structural/environmental defects
- g) Safety for non-target species and the environment

Features of an IPM program

- a) Detail dependent
- b) Emphasizes non-lethal interventions
- c) Effects are multi-dimensional
- d) Habitat modification removes indoor allergen deposits, and can reduce asthma exacerbations  
[New Engl. J. Med., Sept. 9, 2004]
- e) Satisfactory long-term cost/benefit
- f) On-site monitoring is a must

**IPM is the “umbrella” under which all vector/pest management efforts logically reside.**

## Hands-on Exercise

**Time needed:** allow at least 1 hr.

**Instruction for Instructor:** Divide class into groups of 4 to 6 and pass out Assignment, below along with the Warehouse Sketch, also below. Explain the exercise and that they are to work together in groups with one person as the scribe. It will be helpful to verbally relate the information below because it will be faster than having the participants read it silently to themselves. At the end of 30 minutes, choose one group to explain their “IPM Action Plan” and allow other groups to add or question as they go along.

### Assignment: IPM Action Plan for Warehouse Rodent Problem

**Definition:** Integrated Pest Management (IPM) is a decision-making process that uses regular monitoring and record keeping to determine if, when, where and what treatments are needed to prevent or solve pest problems. Educational, legal/regulatory, habitat modification, horticultural, biological, mechanical, and chemical methods might be used to keep pest numbers low enough to prevent unacceptable nuisance, economic damage, or injury & disease. The IPM approach emphasizes long-term pest prevention, using a site-specific combination of environmentally friendly, cost-effective strategies.

#### Instructions:

- 1. Your group will prepare an "IPM Action Plan" that addresses the various problems shown in the site diagram/sketch and described in the background notes. The objective of this exercise is to gain experience using the IPM decision-making process to design a long-term solution to these common rodent problems found in the built environment.*
- 2. Select one person to record your discussion and to describe your group's IPM Action Plan to all workshop participants.*
- 3. Your group has 30 minutes to develop your IPM Action Plan by answering the questions on pages 4 and 5.*

#### Background and Supplementary Notes on Visit to Warehouse

The warehouse location is coastal CA (e.g., Berkeley lowlands/hills interface). This building is in a small industrial park with similar structures nearby. That is, other warehouses are approximately 200ft distant on either side (north and south) of the building. Ice plant (*Carpobrotus chilensis*) is used for perennial ground cover between adjacent properties and begins at about 20-25ft on either side of the building. A six-lane highway borders the property on the east; a two-lane paved road borders the property on the west side with open gravel/soil mix (virtually no vegetation) beyond.

This warehouse is concerned with the storage and shipment of food grains and birdseed. The structural integrity of the building is very good and with no cracks or crevices in the smooth steel exterior. The steel roof is also in excellent, sealed condition. This visit occurred on a summer evening at about 6:30pm; each square represents about 3ft x 3ft. The notes below were made to supplement the on-site sketch and include information provided by warehouse staff via telephone interviews.

**The southern exterior** has 3 almond trees (*Prunus amygdalus*), each @ 20-25ft high and fruiting, and with foliage within 4ft of the south building wall. Algerian ivy (*Hedera canariensis*) covers the nearby ground and much of the building wall (to at least 10-12ft); the ivy is approximately 2-3ft in depth everywhere. The lawn is kept neatly trimmed. The wooden privacy fence provides a decorative screen to hide the rubbish heap on the west side of the fence.

**Western exterior:** The rubbish heap is about 2ft deep at its highest point. The nearby grass and weeds are often not well maintained. The loading dock is cantilevered, with no steps to the ground about 4 ft. below and with an open void area underneath. Clutter (motor parts, truck tires, broken pallets) can be seen in the void. On the northern end of the loading dock is a “burned out” forklift in need of repair. While the driveway has a reasonable covering of gravel, the gravel does not extend under the Loading Dock. The two dumpsters are not well maintained; their drain plugs are missing and they frequently are overflowing or have garbage spilled on the ground. The grass and weeds could be better trimmed. The small drainage ditch is somewhat seasonal, but usually has some water in it, and always has thick weed growth along both banks.

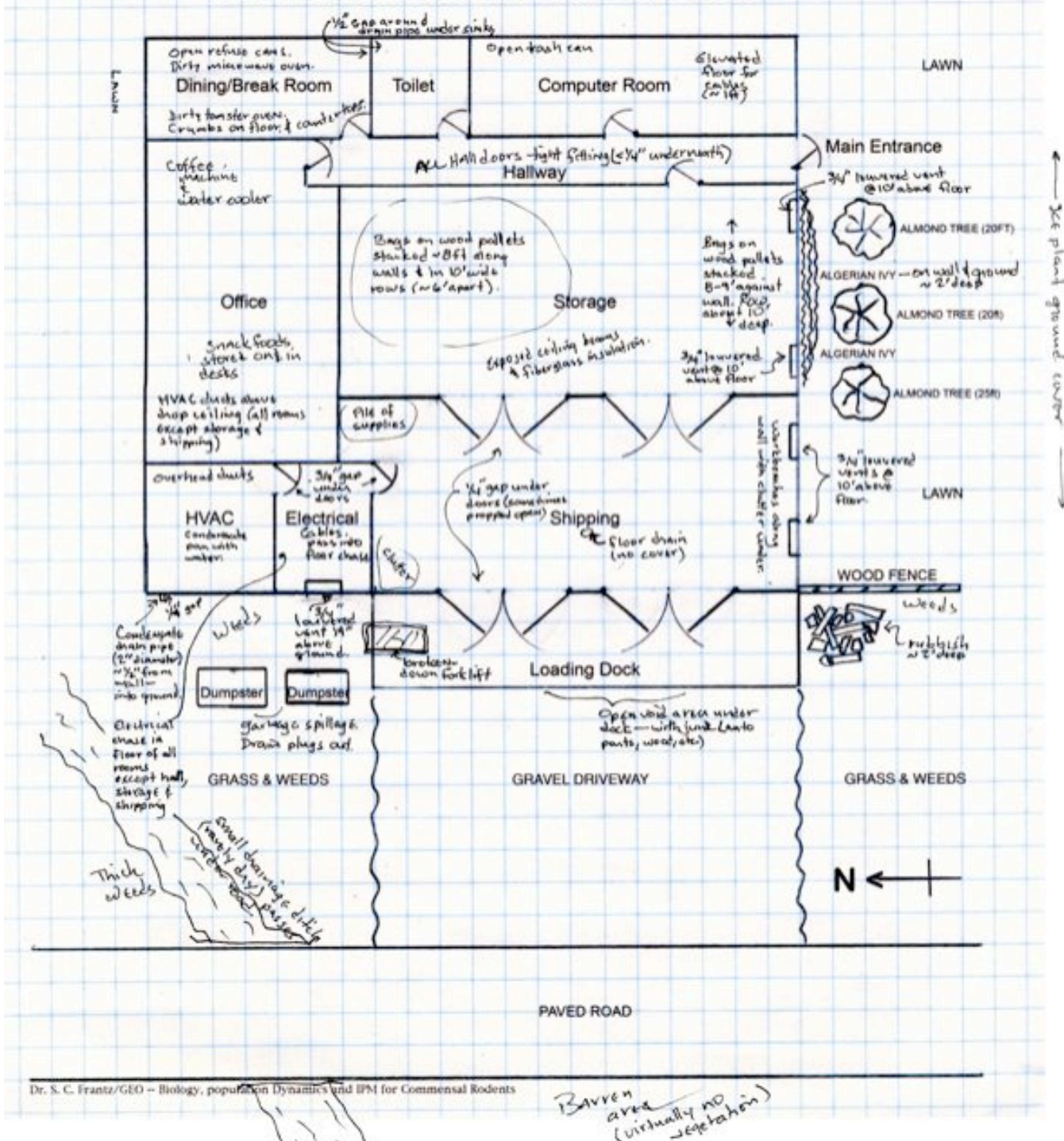
**Staff occupation of interior spaces varies:** HVAC and Electrical Closet = very infrequently & typically in daytime; Computer Room & Office = weekdays (9:00am – 5:00pm, occasionally until 6:00pm), daytime only; other spaces = variable, depending on need. Shipping room and Loading Dock frequently have worker activity until 9:00pm on weekdays. Housekeeping completes all tasks (vacuuming, emptying waste cans, etc.) during the standard 9:00am – 5:00pm work hours.

**Interior conditions included the following:**

- Dining/Break Room: open refuse cans contain some wastes; recycling materials not adequately washed and storage container open; food crumbs in toaster oven and spillage on floor; drain pipe under sink with ½” gap all around.
- Toilet/Bathroom: basically clean; drain pipe under sink with ½” gap all around.
- Computer room: some garbage in waste cans (lined with large plastic bags that hang close to floor); floor of room is raised approximately 1ft to accommodate a multitude of cables for power and networking.
- Office: garbage in some waste cans (lined with large plastic bags that hang close to floor); office workers store snack foods in and on desks; coffee machine with condiments (sugar/sweeteners, creamers) on small table sitting next to water cooler.
- HVAC: ducts for heating and cooling run overhead and above drop ceiling of most of building (excluding Storage & Shipping rooms which are not conditioned); condensate found in collection pan beneath machinery; condensate drain pipe (2” diameter) passes through exterior wall (¼” gap all around pipe) at 2’ above ground, and then downward against wall (approximately ½” to wall surface) into a sealed, subsurface drainpipe; door to Electrical Closet has ¾” gap underneath.
- Electrical Closet: has many cables leading into chases under floor (and then to all rooms except Hallway, Storage & Shipping rooms); gaps between cables and chase walls are typically about than ½” wide; on the W wall is a ¾” louvered vent (without wire mesh or screen) at 14” above the ground; door to Shipping area has ¾” gap underneath.
- Shipping: large swinging doors to loading dock (and to Storage) have ¼” gap underneath; these doors are sometimes propped open to improve ventilation on hot evenings; floor is generally kept clean, but with clutter along northwest wall, northeast corner, and under workbenches along south wall; center of floor has a drain that is missing a grate/cover; above the workbenches are two ¾” louvered vents (without wire mesh or screen) 10ft above the floor.

- Storage: grain and birdseed are stored for both short term and long term (the latter bags of product are stacked as high as 8-9' and 10' deep) on traditional wood pallets along the exterior wall; short term goods are stored similarly in 10' wide rows (about 6ft apart to allow use of small forklift) across the remaining floor area; on the south wall are two ¾" louvered vents (without wire mesh or screen) located 10ft above the floor; exposed ceiling beams are at 12-14' above floor; fiberglass insulation under roof deck meets ceiling beams along south wall.
- Hallway: clean and uncluttered; all doors leading off hallway are tight fitting (<¼" gap under each).

# Warehouse Rodent Problem EXERCISE



Dr. S. C. Frantz/GEO - Biology, population Dynamics and IPM for Commensal Rodents

## **Pest Problems Reported**

- Office workers complain that rodent droppings are often found in desk drawers and on desktops; and that snack foods & packaging are being nibbled.
- Computer Room staff complains that rodents have been seen in the daytime and that cables are being chewed resulting in costly downtime for their computer equipment.
- Staff who use the Dining/Break Room complains that rodent dropping are often found in the food cabinets and on countertops.
- Storage Room staff complains about rodents running about; they say they have had pest control operators place out bait all around the pallets and while some big rodents have been killed the problem persists.
- Shipping Room staff report rodents running about the room, but they don't know how they are getting in or where they go once they are inside.
- The warehouse managers know little about rodents, but want to know why they are having this problem and what can be done about it.

## **Biology and Behavior of Pests That Influence IPM Strategies**

**Commensal Rodents (Norway rats, roof rats, and house mice)** live in and about the built environment, are primarily nocturnal, and require food, shelter, and water resources to survive.

**House Mice** are the least dependent on free water, but will be attracted to available water as will Norway and roof rats. A high protein diet will increase the need of each of these species for free water).

**All three species** are highly attracted to grains. Norway rats also have a fondness for garbage, roof rats for fruit, nuts, and invertebrates that live among ground cover, and house mice for birdseed.

**All three species** are capable burrowers, but this is mostly a characteristic of Norway rats (will also seek shelter under low lying objects). Roof rats are largely arboreal though may have feeding stations under woodpiles and in dense ground cover. House mice in urban areas largely seek harborage indoors, high or low locations, in voids under cabinets and other quiet zones.

## IPM Action Plan Summary Sheet A

1. What are your pest management objectives for this site?
2. What rodent species would you most likely find where; and what route would they most likely utilize to get there?
3. What is the treatment threshold for rodents at this site? List the number of rodents, at what location and of what species, that you think will trigger action for management. How will you know when management interventions have been adequate?
4. How will you monitor the success or failure of your treatment program (e.g., keep a written record of complaints; take photographs of observed rodents or signs of their presence before and at intervals after treatment)?
5. Using the attached background document and the handouts in your binder, describe the various intervention methods you plan to use in order to reduce the existing rodent problems to a level below the treatment threshold. Intervention categories are listed in (a) through (g) below.

For each species, you must plan on using methods from **at least two categories** in order to have an integrated program. Some interventions can be completed by you, by the client (warehouse staff), or by subcontractors. Note which species you will target with each intervention.

**a. Educational** (e.g., which individuals or agencies will you need to educate in order to be successful in implementing your plan? How will you educate them? What do they need to know?)

*Species:*

**b. Legal/Regulatory** (e.g. what regulations might you need to review and what actions might that trigger; which individuals or agencies might you need to alert?)

*Species:*

**c. Habitat Modification** (e.g., sanitation, housekeeping, storage practices, stoppage)

*Species:*

## IPM Action Plan Summary Sheet B

**d. Horticultural** (e.g., change maintenance schedule, remove problem plants, etc.)

*Species:*

**e. Biological** (e.g., encourage predation)

*Species:*

**f. Mechanical** (e.g., trapping)

*Species:*

**g. Chemical** (e.g., repellents, selective toxicants if absolutely necessary, etc.)

*Species:*

**h. Other**

*Species:*

6. How does your plan prevent commensal rodents from becoming a problem again?
  
  
  
  
  
  
  
  
  
  
7. List the key resources (e.g., budget, labor, new professional skills, equipment, etc.) you will need in order to implement your IPM Action Plan.
  
  
  
  
  
  
  
  
  
  
8. List any anticipated obstacles to successfully implementing this IPM Action Plan **and** ways to overcome them.



# Class Exam for Structural Pest Control Board

## Commensal Rodents Session Exams

Name \_\_\_\_\_

1. What are three behavioral ecology issues of commensal rodents that enable them to live so intimately with people?

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2. List 3 types of injury that are often attributed to commensal rodents and result in a reduced quality of life for people.

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3. Circle which of the following enable commensal rodents to gather information about their environment or improve their chances of survival?

1. Neophobia
2. Omnivorous diet
3. Auditory ability
4. Thigmotaxic ability
5. Deposits of urine and feces
6. Gustatory ability

4. Circle the most important habitat factors contributing to the environmental carrying capacity of commensal rodents.

1. Predators
2. Food
3. Climate
4. Traps
5. Social status
6. Harborage

5. When removal tactics alone (i.e., trapping & poisoning) are used against rodents, the population typically bounces back to its original level primarily because: [Circle the correct answer(s)]

1. Human tolerance limit is changed
2. Territoriality intensifies
3. Food becomes scarce
4. Carrying capacity remains unchanged
5. Harborage becomes scarce
6. Short life span

6. What are two major treatment/intervention categories that are most likely to be emphasized in a well-planned (non-emergency situation) commensal rodent IPM program?

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## Commensal Rodent Exam Answer Sheet

### Question 1

Answers = any combination of 3 of the following:

1. Much opportunity to interact with humans
2. Very mobile (found nearly everywhere)
3. May congregate in large numbers
4. Small size
  - a. Easy to gain entry to human and/or domestic animal living space
  - b. Initial utilization of human structures may not be noticed
5. Relatively secretive behavior
  - a. Generally nocturnal or crepuscular activity period
  - b. Utilize remote niches
6. Persistent interlopers

### Question 2

Answer = any combination of 3 of the following:

1. Nuisance & aesthetic
2. Food consumption and contamination
3. Structures and material goods
4. Public Health/Pathological
  - a. Psychological stress
  - b. Bites
  - c. Disease

### Question 3

Answer = all

### Question 4

Answer = Numbers 2 and 6

### Question 5

Answer = No 4

### Question 6

Answer = Any two of the following:

Educational

Legal/Regulatory

Habitat Modification (including Sanitation, Housekeeping, Storage Practices, Exclusion, and Horticulture)

## Class Handouts

### Handout 1

#### **Important Biological Facts about the Roof Rat (*Rattus rattus*), the Norway Rat (*Rattus norvegicus*), and the House mouse (*Mus musculus*)**

### **Biology**

#### ***Habitat***

- **Roof rats** are excellent climbers and are usually found in the upper parts of structures. Indoors, they prefer to nest in elevated areas such as attics and ceiling voids, and in/among stacks or cases of stored goods. They can also nest on lower floors. Outdoors, they usually nest above ground in trees, in dense overgrown vegetation, or in piles of wood or debris.
- **Norway rats** do not climb as readily, or as well, as roof rats and are usually found on the lower parts of structures. Indoors, they typically nest in wall voids and crawl spaces, in basements, in storage rooms under seldom-moved materials, or in any cluttered area that is little used. Outdoors, they nest in the ground in burrows, in trash piles, or in unused sewers or storm drains.
- **House mice** are good climbers and can be found anywhere in buildings, including: in voids under sink cabinets, in cupboards, in drawers, on high shelves, in wall voids, above drop ceilings, and in household goods and clutter. They are more likely to be found indoors than outdoors.
- **House mice, Norway rats, and roof rats** can simultaneously infest a building; however, the different species will likely have somewhat different activity periods and/or different specific areas of activity.

#### ***Food Preferences***

- **Commensal rodents (rats and house mice)** are omnivores, they eat both plant and animal materials, and their “preference” is based largely on what is readily available. Under lean conditions, they may be attracted to unusual items (e.g., the fats in bars of soap). Given a choice, all can be attracted to cereal grains and seeds, and all are capable of selecting a nutritious diet.
- **Roof rats** are somewhat erratic feeders; they prefer fruits, berries, nuts, and seeds. They are frequently associated with avocado and citrus trees. Garden snails, insects, and dog and cat kibble are also favorite foods in some circumstances. Less frequently, they will forage in garbage.
- **Norway rats** are steady eaters; they prefer cereal grains, seeds, nuts, meats, and fish, but will eat almost anything. They commonly forage in garbage.
- **House mice** are very erratic feeders (nibblers); they prefer cereal grains and seeds such as birdseed. They will eat many items, including insects, frozen meat, flour, snack foods, and candy. They do not commonly forage in outdoor garbage cans, but will be found taking advantage of food materials in indoor waste cans.

#### ***Habits and Physical Abilities of Roof Rats, Norway Rats, & House Mice***

- **These rodents usually search for food between dusk and dawn**; however, they are adaptable if warranted by circumstances. Indoor mice are generally nocturnal, but less predictable than rats.
- **Prefer to travel along, and in contact with, vertical surfaces** (e.g., the floor/wall interface, along/against the outside or inside of a building foundation) rather than in open, exposed areas. All will travel along pipes or rafters; roof rats are particularly adept at running along overhead utility lines.
- **Are wary of crossing open spaces that provide no cover.** Hedges and other dense vegetation in landscaping or growing against buildings provide cover for rodent trails.
- **Norway and roof rats tend to be extremely wary (though temporarily—for a few hours to a few days) of new objects** in an otherwise stable environment.
- On the other hand, **mice readily investigate new objects** and changes in their environment.
- **Young rats can fit through cracks and crevices of about ½ inch high.** *Note:* the average adult rat skull is roughly 1 inch high x 1 inch wide.

- **Young mice can pass through cracks and crevices of about ¼ inch high (the width of a pencil).** *Note:* the average adult mouse skull is ¼ inch high x 3/8 inch wide.
- **As a “rule of thumb,”** adult rats can pass through holes the size of a quarter; adult mice can pass through dime-sized holes.
- **Rats can climb** inside vertical pipes measuring 1½” to 4” in diameter and climb the outside of vertical pipes measuring up to 3” in diameter, or the outside of vertical pipes of any size if they are within 3” of a wall.
- **Roof rats can run on narrow gauge, loose wires** or ropes as if they were a rigid board.
- **Norway rats can jump** horizontally at least 4’, and vertically (from a standstill) at least 24” above a flat surface (this increases to 3’ with a running start and using a vertical surface as a spring board). They can reach about 13” above a flat surface.
- **Roof rats can jump** vertically (from a standstill) at least 24” above a flat surface (this increases to 4’ with a running start and using a vertical surface as a spring board).
- **Mice can jump** vertically (from a standstill) at least 12” above a flat surface (2’ with a running start).
- **Each of these rodents will gnaw and leave marks on almost anything,** including wood, chip board, lead pipes, cinder blocks, soft asphalt, aluminum, sheet metal, sun-dried adobe, and the exposed edge of a piece of glass. Galvanized sheet metal and hardware cloth are generally impervious to attacks by commensal rodents, but rodent teeth can mark them.
- **Rats and mice are generally good swimmers.** Norway rats and roof rats readily swim up through the water seal, or trap, of a toilet (or floor drain) to gain entry to a building from a sewer. Mice are less likely than rats to dive below the surface of water.

## Signs of Rodent Presence

### *Live or Dead Rodents*

- Because they are mainly active at night, live rats that are seen in the daytime usually mean that either there is a heavy infestation, that their harborage has been disturbed (perhaps by construction), or that new rats are moving into the area and have not yet found any harborage. It can also mean that a small or medium infestation of rats has developed a daytime feeding pattern in response to periodically available food, such as kibble being placed out for pets at a certain time every day.
- Because mice can be active during the day, seeing them during the day does not necessarily indicate any special conditions.
- A freshly dead rodent indicates a current infestation, but an old, dried body may merely indicate a previous infestation.
- Always use safety equipment, including rubber (vinyl, latex) gloves, goggles, a HEPA filter respirator, disposable coveralls, and disposable shoe covering when removing rodent bodies. Spray the carcasses with a mild disinfectant, such as 8 oz (1 cup) household bleach in 5 quarts of tap water. *Note:* in a disease outbreak area, a more potent disinfectant should be used, such as 7 oz household bleach in 2 quarts of tap water. Adding a small amount of a wetting agent (e.g., a detergent) to the solution will improve suppression of dust particles (including dried feces or urine) and the bleach will destroy harmful microbes.

### *Droppings*

- Always use the safety equipment described above when conducting inspections or removing rodent droppings and carcasses, especially when working in cramped unventilated spaces. Moisten droppings with the mild disinfectant (see above) to prevent particles from becoming airborne and to destroy any harmful microbes on the droppings and dusty surfaces. If you encounter piles of droppings, be sure to thoroughly moisten each layer with the disinfectant.
- The greatest number of droppings will be in favored feeding areas and near harborage.
- Norway rat fecal droppings are typically large (up to >3/4” [20-25mm] long), sausage-shaped and normally pointed on one or both ends, and often found in small groups. Roof rat droppings are medium sized (up to >1/2” [15mm] long) blunt, sausage-shaped and frequently curved, and found scattered about (may be concentrated in favored locations). Mouse droppings are small (up to >1/4” [7.5mm] long), often pointed on one or both ends, and generally widely scattered (but may be concentrated in favored places).
- Some bat droppings resemble mouse droppings in size; however, bat droppings are more irregular in shape, crumble easily under pressure, and a closer look will usually reveal shiny undigested chitin and other insect parts.

- Droppings all of a uniform size can indicate an infestation of a single rat; many different sizes can indicate a breeding population. Remember that rodents of different ages produce droppings of different sizes that can add some confusion in analyzing rodent presence, especially in multi-species infestations.
- Fresh droppings are moist and soft (putty-like), and they glisten or look wet. After a few days, the droppings dry, become hard, and appear dull rather than shiny. After a few weeks, rodent droppings often become gray in color and may crumble easily.
- If old droppings are moistened (deliberately or from rain, irrigation etc.) they may look like fresh ones, but they will still be crumbly instead of soft (not putty-like).
- In order to monitor for current rodent activity, remove the droppings so that fresh droppings are apparent during future inspections.

#### ***Damage to Goods and Structures***

- Rodents gnaw to get at food within packaging or containers, to obtain nesting material, and to pass through building walls.
- When they gnaw, Norway rats leave 2 shallow parallel grooves  $>1/8''$  (3.5mm) across; the marks for mice are  $>1/16''$  (2mm) across.

#### ***Grease Marks or Rub Marks***

- These marks (along walls, around access holes, on beams, rafters, walls, pipes, and other fixtures) are the result of oil and dirt rubbing off rats' fur along frequently traveled routes. Loop marks formed beneath roof trusses or floor joists are characteristically unbroken for Norway rats, are broken (weaker in middle) for roof rats, and for house mice are similar in appearance to Norway rats, but much smaller.

#### ***Runs (Runways) or Burrows***

- Norway rat runs are most typically observed outdoors along foundations, walls, or fences or under bushes or debris.
- Roof rat runways are often not well defined unless in elevated locations.
- Mouse runways are most readily seen in dusty places, except when the infestation is heavy.

#### ***Tracks***

- Footprints and long, thin marks of a tail being dragged or rested can easily be seen on dusty surfaces, in soft soil, sand, and snow.
- Tail drag marks are more likely to be made by adult Norway rats than by roof rats or young Norway rats, both of which carry their tails high.

#### ***Noises and Smells***

- Sounds of gnawing, clawing, fighting, and scrambling are particularly audible at night when rodents are most active.
- Norway rats, roof rats, and house mice each impart a distinctive odor to an area over time.

## Handout 2

### Summary of COMMENSAL RODENT Management Techniques Most Compatible with an IPM Program

For rodent IPM to be effective, it must combine eliminating rodents within a building with preventing rodent entry to the building. Only if this is done systematically, thoroughly, and completely will you achieve success.

#### Inspection and Monitoring

- Make a site plan to record your findings.
- Inspection must be detailed and thorough both indoors and outdoors.
- Look for signs of rodent presence (see previous pages).
- Note all possible harborage sites, sources of food and water, and routes that provide entry to a building.
- Use a non-toxic tracking powder such as chalk dust, unscented talcum powder, diatomaceous earth, etc. on smooth surfaces to gain more information about rodent movements and access routes.
- Note bird and bat problems because customers may confuse some bird or bat signs with rodent signs; also rodents may be attracted to feed on bird eggs, chicks, and young bats.
- Inspect vegetation for feeding sites, burrows, nesting sites, runways, and possible access routes to the building or roof. Look for fruit- or nut-bearing trees.
- Look for pipes and utility wires that provide access to the building or roof.
- Inspect garbage, rubbish, and recycling storage facilities.
- Inspect all planters, woodpiles, pallets, boardwalks, portable storage containers, and outbuildings.
- Look for piles of trash, clutter, and other debris both indoors and out.
- Establish a monitoring program (repeated inspections) that will provide the necessary information at frequent enough intervals to manage a specific rodent problem.

#### Interventions (highlights only)

##### *Education*

- Educate the customer (and/or community), regarding rodent biology and behavior, and explain actions the customer can take to discourage rodent presence and to interfere with rodent survival. ***This is the single most important intervention.***
- Tailor the education or communication to the situation. The form can be varied from one-on-one discussions to mass media.

##### *Legal/Regulatory*

- Inform customers about codes, ordinances, and laws pertaining to specific pest problems. This is a form of education that keeps customers aware of their legal rights, or of liabilities that could motivate them toward compliance.
- In some cases, it may be necessary to inform regulators of client practices that endanger the health and welfare of people, domestic animals, or the environment.

## Handout 2: INTERVENTIONS (cont.)

### *Habitat Modification*

- Sanitation
  - Store all garbage in rodent-proof (or at least rodent-resistant) containers and make certain all indoor garbage is moved to outdoor storage each evening (no overnight garbage indoors).
  - Be certain that all indoor and outdoor garbage containers are emptied frequently enough to prevent overflowing, and that such containers are thoroughly washed with soap and water no less than every 2 weeks.
  - Never leave pet food exposed (indoors or out) before or after pets eat. You cannot count on pets to keep rodents away.
  - Promptly clean up spilled birdseed around feeders.
- Housekeeping and Storage Practices
  - Rodent droppings and urine-contaminated dust and debris should be removed with a HEPA-filtering vacuum cleaner; this is especially important in living quarters.
  - Hard surfaces that have been contaminated with rodent urine and/or droppings should be washed with soap and hot water.
  - General food materials (snacks, groceries, etc.) should be stored in rodent proof (or rodent resistant) containers. This includes pet kibble and grass seed.
  - Very large containers of food (e.g., cartons of breakfast cereal) should be stored on shelving beginning at least 18” above the floor and in narrow rows (6ft wide or less). Shelving should be kept at least 18” from walls.
  - Unused items and clutter should be stored as mentioned above or discarded.
- Exclusion
  - Make general building repairs, and block all unnecessary openings that are accessible to rodents with materials that prevent rodent entry.
  - Seal openings of ¼” or larger (smaller if insect pests are also present) in building exteriors. Interior holes should also be sealed depending on severity of infestation and threat of reinfestation. Seal small holes with knitted copper mesh (copper will not rust) and cover with caulk or other finishing compound. Larger holes can be sealed with sheet metal, cement, expanded metal, hardware cloth, or other impervious materials.
  - Cover air vents with ¼” hardware cloth.
  - Seal gaps where pipes, wiring or other conduits pierce a building’s exterior shell. Similarly, seal interior openings that would make it possible to limit rodent movements to particular rooms or areas.
  - Weather-strip doors and windows, use metal kick plates, brush/vinyl door sweeps, automatic drop sweeps, and/or raised metal thresholds.
  - Make sure all HVAC units are well sealed from rodent access, especially those on the roof.
  - Repair underground and basement sewer pipes that are broken.
  - Install threaded caps on sewer pipe clean-outs.
  - On open floor drains, install grates with small openings (e.g., ¼” holes); similarly, block rodent entry to outdoor drains.
  - If a building’s construction is still in the planning stage, encourage or initiate rodent proofing designs (prevention of rodent infestation is always easier to accomplish than post-infestation management).

## Appendix 2: INTERVENTIONS (cont.)

### *Horticultural Controls*

- Regularly trim all lawns and bushes; stay aware of any rodent activity.
- Thin out or replace dense shrubs and bushes; replace dense groundcover with less dense varieties or alternative species.
- Regularly pick up fallen fruit and nuts outdoors.
- Remove groundcover, grass, weeds, and bushes within 2' of buildings; replace with inspection strips of pebbled rock (at least 2' wide x at least 6" deep).
- Trim tree/shrub branches at least 3' to 6' away from buildings. Trim overhanging branches. Keep vines off building walls.
- Break up dense plantings, stretches of lawn, or very low groundcover with pathways (pebbled rock at least 6" deep and at least 36" wide recommended), to discourage long rodent runs.

### *Biological Controls*

- Encourage the introduction and conservation of appropriate predators (e.g., peregrine falcons, owls, and snakes) that could reduce (not eliminate) rodent numbers, and would add interesting species diversity to the built environment.
- Cats can “prune” a rodent population but will seldom eliminate it, and in most situations should not be counted on as a deterrent.

### *Mechanical Controls (Trapping)*

- As a supplement to the preceding interventions, place properly sized traps (snap traps, live traps [internal trigger only], or glue boards [inhumane and less useful for rats]), and record their locations on your site plan/sketch.
- Monitor traps regularly (at least daily) and keep bait fresh. Rodents generally will not feed on dried or rancid bait. Frequent monitoring keeps the most traps available, and allows removal of malfunctioning ones and repositioning of ineffective ones.
- Snap traps and live traps do not need to be cleaned, except to insure proper functioning of the trigger and capture mechanism, and may be more attractive when soiled with rodent odors.
- Always use safety equipment including rubber (vinyl, latex) gloves, goggles, a HEPA filter respirator, disposable coveralls, and disposable shoe covering when servicing traps

#### Setting Traps

- Set snap traps with the trigger end facing the wall and the edge of the trap flush with the wall. Two or three traps in a row will make it difficult for rodents to jump over them without being caught.
- Snap traps can also be set parallel to the wall, back to back with their triggers facing away from each other. Live traps can be similarly set, with their open ends facing away from each other. Set glue boards with the long side touching the wall.
- Nail snap traps to walls, rafters or trees, or wire them to pipes with the trigger projecting into the runway. Live traps, with internal trigger mechanism, can be set/hidden under debris, piles of clutter, etc. and still are functional. Lightweight cardboard glue boards can be wrapped around a pipe (held in place with thin wire ties)
- Move objects around to funnel rats into traps. Also use objects to protect traps from non-target species, or place traps (snap or glue) inside large tamper-resistant bait stations or in ready-made snap trap stations, or place traps in areas/rooms inaccessible to non-target species.
- Use plenty of traps, preferably in groups. Trapping intensely for a few days is generally more effective than distributing traps sparsely over a wide area. Think three-dimensionally; experiment to learn what pattern of trap placement works best in each situation. Remember, traps must be positioned so that rodents easily encounter them in their normal activity areas.



## Appendix 2: INTERVENTIONS (cont.)

### *Baiting Traps*

- For bait choices, use foods the rodents are already known to be eating, or try baits that could be highly competitive with the rodents' standard diet including the baits listed below.
- Baits for Norway rats include peanut butter, pieces of hot dog, singed bacon, nut meats, and fresh apple slices.
- Baits for roof rats include nuts, dried fruit, fresh apple or banana slices, candy, marshmallows, raisins, or peanut butter.
- Baits for house mice include peanut butter, peanut butter mixed with bacon grease, raisins, gumdrops, and chocolate candy.
- Baits that don't stick to the trigger can be tied on with string, dental floss, or very thin wire.
- It may be necessary to "pre-bait" traps (snap or live) for a few days to enhance trapping success. Place traps out with bait, but do not set the triggers. Check daily to see if bait is taken and replace. When the take is steady, add a very small amount of fresh bait to the underside of the trigger, and set triggers. Rodents will be likely to manipulate the trigger looking for the bait that they were accustomed to finding and that they can now smell.

### *Chemical Controls*

- In general, chemical controls should be used only as a last resort or in emergency situations. Thus, for most commensal rodent infestations, especially residential, rodenticides usually can be avoided altogether.
- If the risk of disease is significant, rodenticide bait application could be warranted both indoors and outdoors when combined with more sustainable actions, particularly, intensified habitat manipulation, mechanical, and educational interventions.
- Remember, depending on the toxicant used, non-target species (children, pets, domestic animals and wildlife, including rodent predators), can be poisoned from either eating the rodenticide directly (eating exposed bait) or indirectly (i.e., eating a dead rodent containing the rodenticide). *No rodenticide should be applied unless it has a very effective, readily available antidote that can likely be administered soon enough to save the life of the poisoning victim.*
- Because of the inherent risks of accidental poisoning of non-target species, the rodenticide of choice should be first generation anticoagulant products (e.g., warfarin) that have a relatively wide margin of safety. Where anticoagulant rodenticide resistance is a concern, the resistance can usually be overcome if at least 30 days is allowed to lapse between exposures. In other cases, simply apply good IPM practices; no rodent will be resistant to the resulting lack of food, water, and shelter.
- Carefully follow all label guidelines for the specific rodenticide bait being applied; typically, place the bait in tamper resistant bait stations that are securely locked and anchored to a heavy or immovable object (indoors—floor, wall, other structural member; outdoors—paving block, fence, into the soil, etc.).
- Another potential downside to rodenticide applications, especially indoors, is that poisoned rodents may die in inaccessible places and cause odor and fly or other problems (e.g., dermestid beetles, aesthetic issues).

### *Ultrasonic Devices and Electromagnetic Devices*

There is no compelling scientific evidence to show that these devices kill or repel rodents (or any other pests) in a dependable manner; thus, such devices have no role in rodent IPM programs.

## Handout 3

# Rodent Trap Notes

### Single-Capture/Kill Traps

**Purpose:** Capturing and killing one rodent at a time

**Description:** Wood- or metal-based snap trap (break-back trap)  
Comes in sizes for rats or mice

**Advantages:** Snap traps are commonly available, small and convenient to carry, and lend themselves to placement in strategic locations on top of the soil, on the floor or in elevated (vertical or horizontal) positions.

**Expanded Trigger to Increase Effectiveness:** Effectiveness can be increased by expanding the size of the trigger (treadle) and positioning that end against the wall: this makes it possible to trap without using bait. Snap traps can also be purchased in the expanded trigger design.

**Products:**

- JT Eaton—Traditional design with standard trigger (available in rat and mouse sizes) or with expanded trigger (no bait necessary)
- JT Eaton Rat Size Snap Trap Station—for partial protection of snap traps from non-target species
- Victor Standard Pedal Trap (metal)
- Victor Easy Set (expanded trigger design)

### Single-Capture Live Traps

**Purpose:** Capture one rodent at a time and alive

**Notes:** Designs with internal trigger mechanisms are best.

Available in wire mesh construction, galvanized steel or aluminum sheet metal.

**Products:**

- Tomahawk Chipmunk/Rat Live Trap (16" x 5" x 5") [excellent live trap for rats]
- Tomahawk Chipmunk/Rat Transfer Trap (16"x5"x5")
- Tomahawk Enclosed Rigid Mouse/Vole Live Trap (10" x 3" x 3") [very similar to the galvanized mouse-sized Sherman below]  
Tomahawk has excellent accessories such as, Detachable Trap Covers and Trap Dividers
- H.B. Sherman (box traps of galvanized steel or aluminum, and in folding or non-folding designs)—for rats (3"x3.5"x9"); and for mice (2"x2.5"x6.5") [excellent live trap for mice]  
H.B. Sherman has an excellent parts list for repairing their traps.

### Multiple-Capture Live Traps

**Purpose:** Capture more than one rodent at a time and alive

**Notes:** Designs with internal trigger mechanisms are best

Available in wire mesh construction, galvanized steel or aluminum sheet metal

**Products:**

- Tomahawk Double Door Small Rodent Trap (24"x3.5"x3.5"), for rats [maybe mice too?]
- Double Door Medium and Large Rodent Trap (30"x4"x4" or 36"x5"x5"), both for rats
- JT Eaton Repeater Multiple Catch Mouse Trap (about same as the Tin Cat)—Clear Viewing Window or Solid Cover
- Wind-Up Repeating Mouse Trap [appears to be the same design as the original Ketch-All design that may not be manufactured any longer]
- Victor Tin Cat Repeating Mouse Trap [probably as effective as the Wind-Up design above, but can be placed under low-lying furniture or other objects]

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