A partnership of the Public Policy Research Center at the University of Missouri-St. Louis and the St. Louis Lead Prevention Coalition.

- A 12-month project
- Funded by a grant from the EPA
Project Objectives:

• Create accessible resource materials for low-income, minority and immigrant households that have been or are at risk for being impacted by the bed bug epidemic;

• Train code enforcement and social service agency personnel in strategies for limiting and preventing bed bug infestations; and

• Develop model ordinances for adoption by local governments.
Why a Bed Bug Project?

• Bedbugs are becoming a common problem across the U.S. – they are here!
• There is no current centralized data being collected in the St. Louis area on incidence but local health departments and pest management companies report increased calls
• Desire to proactive – there are cases but not yet on scale of other cities
• Development of education to assist social service workers and clients, help agencies establish procedures, and model ordinance to help communities establish awareness and policies
Special Thanks
to the following for their assistance, their expertise, and permission to use materials

• Erik Foster, MS, Medical Entomologist, Michigan Department of Community Health and the Michigan Bed Bug Working Group
• Dini M. Miller, PhD., Dept of Entomology, Virginia Tech
• Purdue University Cooperative Extension
• Northern Kentucky Health Department
Our goals

• To learn how to identify bed bugs and the health concerns surrounding them
• Identify risk factors for clients, social service workers and residential facilities
• Learn various strategies to prevent/contain bed bugs
• How to protect yourself and your office
• Resource information
Health Issues and Bed Bugs

• Anemia has been reported in young children and elderly living in bed bud infested homes
• Studies in Egypt found that allergens excreted in bed bug environments can produce reactions in persons with asthma. The presence of bed bugs in a living environment may exacerbate symptoms in sensitized asthmatics.
• Cause severe anxiety and stress
• Reactions range from mild to severe irritation, secondary infections
• Topical insecticides such as those used for head lice and scabies, and repellants have no effect on bed bugs, their use as well as other pesticide use may cause additional health problems
Bed Bug Basics

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Order Heteroptera (True bugs)

- Family Cimicidae
- Originally cave dwellers (Middle East) that were ectoparasites of bats
- Humans moved into the caves so bed bugs started to feed on humans
- Humans have transported bed bugs all over the world
US History of the Bed Bug

- Common pest in the US at the turn of the century
- Essentially eradicated in 1940-50 due to DDT
- Resistance documented to DDT, malathion, carbamates and pyrethroids
Why are Bed bugs back?

- International travel?
- Reduced baseboard spraying?
- Misidentification?
- We don’t know how to treat?
- Wartime pest?
- Increased pressure of resistant populations?

World-wide resurgence: Pest control operators report a 100-500% increase in bed bug jobs in US, Europe, and Singapore
So What Are They Doing?

- Aggregate in cracks and crevices all day
- If hungry they become active between midnight and 5:00 am
- Stimulated by and increase of CO₂ in the room
- Will travel many yards to get to a host
- We still don’t know exactly how a bed bug finds the host
Bed Bug Feeding

- Probe the skin to find a capillary space that allows the blood to flow rapidly
- May probe the skin several times before feeding.
- Feeds for 5-10 minutes
- After feeding, leaves the host to aggregate
- Bed bugs usually feed every 3-7 days
Feeding Behavior

- Most of the time, the majority of the population is in the digesting state.
- Old literature claims that adults live for a 1 year without feeding.
- However, recent research indicates that all life stages live only ~70 days without feeding.
- However, they can live longer at cool temperatures <40°F.

May void part of previous meal while feeding
Right After Feeding?

- Right after adults take a blood meal they become very interested in mating, particularly the males.
- They engage in traumatic insemination.
- The male stabs his paramere through the female wall into a specialized organ on her right side, called the Organ of Berlese.
- The male sperm is released into the female’s body cavity, where over the next several hours it will migrate to her ovaries and fertilize her eggs.
- Females may be mated with as many as 5 different males.
- We have seen females begin to produce eggs within one day of mating.
Consequences of Mating

- The female’s body must heal from this wound.
- Females are known to leave aggregations after being mated several times.
- The process of healing from mating has an impact on the female’s ability to produce eggs.
- Females that mate only once will produce 25% more eggs than females that are mated repeatedly.

Will mate when skinny as well.
Why do you care?

- A single mated female brought into a home can cause an infestation without having a male present
- Must have regular blood meals
- The female will eventually run out of sperm, and will have to mate again to fertilize her eggs.
- She can mate with her own offspring after they become adults.
Egg Production

- The total number of eggs a female can produce is dependent on feeding frequency not the number of matings.
- After taking a blood meal the females produce 5-20 eggs over the course of 10 days.
- She will not reproduce again without feeding.
- However, she can reproduce without mating again and even up to 25% more offspring!!!!!

These eggs are about to hatch (~5 days old). You can see the eye spots of the developing nymphs.
Population Growth

- Eggs can be laid singly or in groups
- About 97% of all eggs will hatch successfully
- Females in the laboratory begin to die after about 9 feedings
- Average females produces ~113 eggs in her lifetime
- Under optimal conditions the population can double in ~16 days
Egg Hatch Time

- Our lab observations indicate that about 64% of the eggs hatch between days 6 and 7.
- Greater than 90% are hatched between days 8-9.
- Temperature will influence hatch time

Hatching bed bug nymphs
Nymph Survivorship

- The *first instars* (newly hatched nymphs) will need a blood meal within ~3 days before they start to die.
- The early death is most likely due to dehydration (moisture loss) rather than starvation.
- Many first instars probably die because their egg was laid too far from a host.
What is the bed bug lifecycle?

- Bed bugs go through 5 nymphal instars before they become adults.
- Each instar must have a blood meal to molt to the next stage (5-8 days).
- If no host present it does not molt.
- First instar to adult in ~37 days.
Fed and Unfed Nymphs

Incomplete blood meals and starvation will prolong development
Adult Life Span

- An adult bed bug at >70°F will live between 99 and 300 days (laboratory).
- We do not know how long a bed bug will live in someone’s apartment (several months).
- Conditions are tough in human dwellings (finding food, temperature and humidity, insecticides, being crushed etc.)
- Resistant bed bugs have shorter life spans and reproduce less than non-resistant bugs
The Signs of Bed Bug Presence

• Bed bugs have to be brought in
  – Traveling
  – Used furniture
• First indicator is unexplained itching red welts
• Bites suggest bed bugs but are not definitive
• Medical doctors are terrible about diagnosing bites!
Bite Reactions (the first indicator)

- My technician’s arm one week after feeding 1000s of bed bugs.
- My arm one week after feeding 60 2-3rd instar bed bugs.
- My student’s arm 1 year after feeding mixed stage bed bugs.
• Bites
  – One study found only 30% had a reaction when bitten by a bed bug.
  – Another study indicated that 96% (of refugees in Sierra Leone) had reactions.
  – Reaction will vary depending on your immune system and Number of bites
  – More evidence is needed than bites to confirm bed bugs
Bed Bug Evidence

- Fecal spots (bed bug poop)
  - Mattress seams and on the tag
  - Wood frame of the box springs
  - Behind the head board
  - Along the tops of baseboards or the edge of carpeting
  - Ceiling/wall junctions and behind pictures on the wall
  - At electrical outlets
  - In curtain seams

- This is blood that has gone through the gut of the bed bug.

- Looks like cockroach feces but feels very different
Bed Bug Evidence

• Molten skins (exuvia)
• The molten skins can be found in bed bug aggregations or by themselves
• In a new infestation, bed bug evidence may be very hard to find. Yet, because a large percentage of any bed bug population is immature, there is always potential to find molten skins.
Hard to Find but Obvious
Less Obvious Unless You Know

- What does this look like to the untrained eye?
- Is it a moisture leak upstairs?
- Mildew that is getting out of control?
- Look closer and see what is really there.
- Bed bug aggregations
Bed Bug Basics: Social Issues

- Bed bugs still have a stigma
- Everyone wants to blame or have someone else pay for the problem
- Residents worry about neighbors or management finding out
- Hotels worry about the internet reviews
- It has been slow trying to get community-wide bed bug programs started
- Other people are obsessing about bed bugs
Other Social Issues

- Rise in low-income infestations where people cannot afford control
- Language barriers, hiding, denial, lack of literacy are contributing to the spread
- Resident using and misusing their own insecticides
- EPA is particularly concerned about non-registered insecticides being purchased over the internet
Health Issue: Stress

- Stress (after an infestation)
  - Sleeplessness
  - Medical bills
  - Destruction of self-image
  - Throwing out all belongings
  - Moving
  - Legal action

- Stress (no infestation)
  - Waking family members in the middle of the night or pulling out the furnace
  - Moving, and moving and moving!
Social Issues: Lawsuits

- NYC >2000 summonses in 2006
- The questions:
  - Did the hotel know they had an infestation?
  - Should they have known?
  - Was there a prevention program in place?
  - Can a landlord charge tenants for bed bug control?
- Claims:
  - Damage
  - Injury (bites)
  - Emotional stress

Leslie Fox: lawsuit for 21 million
Legislation

  - Property Owners and Operators “shall not have a public nuisance on the property”
  - Tenants must clean and cooperate with owners and PCOs or be cited
  - PCOs have guidelines for inspection and treatment procedures
- 2009 Virginia HB 2080- Landlord is to maintain fit premises. Tenant shall prepare the dwelling for pesticide application according to management instructions. If insects are found...
Why We Don’t have “the Answer”

- Most products will kill some bed bugs if you apply them directly.
- Sprays have low residual efficacy.
- Consumers do not realize that killing bed bugs *we can see* is not the problem.
- Our problem is stopping the infestations.

Why not just hit each bug with a hammer?
Bed Bug Basics Summary

• Bed bugs biology and behavior contributes to their success as a pest
• We must be able to recognize the signs of an infestation early on to deal with bed bugs effectively
• We must understand the social issues regarding bed bugs, and be able to work with those issues
• We must be in acceptance that (right now) there is not single insecticide product that capable of eliminating bed bugs
• All treatment is time consuming and expensive
• There is no pest management company that can work a miracle overnight
Possible Client Risk Factors

- Periods of homelessness/shelter/transitional housing
- Second hand furniture/mattresses/donated clothing and toys
- “Dumpster Diving” for income; works in homes
- Public transportation
- Uses laundramats
- Multifamily housing/moves frequently
Social Service Workers: Risk Factors and Protecting Yourself

• Conducts home visits
• Routinely visits shelters or daycare settings
• Transports clients and belongings
• Collect/distribute donated items
• Conduct client intake/ interviews in office
• Perform Home inspections
• Works with elderly clients
• Routinely visits healthcare facilities

• Protect your self by:
• Not bringing bags or personal belongings into homes; only necessary files
• Bring a portable stool/chair or sit on a hardback chair – sit in the middle of the room
• Turn up pant cuffs; do not take off coats/jackets
• Shake out clothes or have a set of field clothes that you store in a sealed plastic bag
• Learn to identify bed bugs, signs of infestation and bites
Risk Factors/Strategies for Residential Facilities

• Items brought from home need to be inspected
• Check wheelchairs, motorized carts and disinfect, store AWAY from sleeping areas
• Establish a procedure for checking patient laundry/items brought in by family

• Thoroughly inspect donated books, games and magazines
• Check all patient belongings upon return from hospital
• Establish a bed bug policy for patients, staff, and families
• Train staff to identify bed bugs and bites
Special Tips for Shelter/Transitional Facilities

- Incorporate bed bug/public health pest questions in intake
- Develop a policy statement including procedures for inspecting belongings, methods of treatment and prohibitions against bringing certain items into the facility
- Ban all cardboard boxes from the facility; use clear plastic bags for clothing and other storage
- Sort any donated items on a tile floor inside a perimeter of double-sided carpet tape
- Wash and especially DRY on HOT all clothing, shoes, coats, linens, blankets, and plush toys before distribution
- Use high quality vinyl mattress and box spring encasements
Bed Bug Prevention and Detection

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Prevention While Traveling

- Whether traveling in the United States or internationally, there are hundreds of places where your luggage might come in contact with bed bugs.
- Bed bugs might be in your hotel room, in the trunk of the taxi, in the luggage compartment of the airplane, or in the baggage handling facility at the airport.
- You cannot control your bag’s travel experience, but you can inspect your hotel room, and you can inspect your luggage prior to bringing it into your home.
Bed Bug Awareness

• Prior to the 1950s, most people had a certain level of “bed bug awareness”. Whenever they left home, in the back of their minds, they were conscious that they might encounter bed bugs.

• They were conscious where they put their personal belongings.

• They inspected their hotel rooms before staying the night.

• Where is your purse or jacket right now?
Give the mattress an inspection before opening your suitcase:

- Pull back all of the bedding at the head of the bed to look for evidence
- Check the underside of the mattress tag and the seams of the mattress and the boxsprings
- If possible remove the head board from the wall and inspect the back of it
- If evidence is found, report it to the management
To Protect Your Luggage

• Do not place your suitcase on the spare bed
• Inspect the luggage stand and place your bag on the stand away from the wall.
• Keep your clothing in your bag, do not place your belongings in drawers
• Give a quick check to the closet for bed bug evidence before hanging clothes
• Place your shoes in an open area, not under the bed or in the closet
To Protect Your Home

• Upon returning home, unpack your luggage immediately, not in the bed room
• Launder all clothing.
• Inspect your bag for bed bugs.
• If you believe that your bag does have bed bugs:
  – Place your suitcase in a plastic bag.
  – Put it out in the hot sun or in the hot car for a day.
  – Put a fumigant strip (NoPest® strip) inside the bag.
  – Purchase a collapsible heat chamber designed for heat treating luggage (PackTite Portable Bed bug Killing Unit™).
• Using a soft bag like a duffel style bag will allow you to put the bag in the dryer when you get home.
• Used furniture is the primary cause of bed bug infestations at the moment.
• While no taking a mattress out of the dumpster may be an obvious risk storing your son or daughter’s furniture after they finish college may not be so obvious.
• These days, you need to be conscious of ways bed might be transported into your home.
Avoiding Used Furniture

- Do not purchase refurbished mattresses or couches
- Do not purchase furniture at a garage sale or antique store without inspecting it first
- Never rent or store anyone’s furniture in your home
- Do not purchase used books without inspection
Avoiding Used Furniture

• If you purchase a new mattress (or any piece of furniture), do not have it delivered to your home.

• If you are helping a friend move, be sure to inspect your vehicle once the belongings have been removed. Bed bugs do not usually survive the hot car, but the car is an excellent habitat during the cooler weather.
Visitors in Your Home

- Be conscious of what visitors might bring with them in their bags.
- If your mother is coming for Christmas, from your childhood home in Iowa, you have nothing to be concerned about.
- If your mother has been at a rest home for the last several years, you may want to inspect her things (discretely) as you are unpacking them.
- If your daughter is coming home from abroad in Asia, and she is bringing several of her Swedish backpacking buddies, you may want to inspect their bedroom after they leave.
Laundry Mat

- Bed bug victims have been told to bag their washables and put them into a hot dryer.
- Most will go to the laundry mat to do this massive washing.
- What do they do with those bed bug infested plastic bags?
- They put them in the trash.
At the Laundry Mat

- Do not transport laundry in cloth bags. Use white, plastic baskets that are easy to inspect when they are empty.
- Do not set your laundry basket on the floor, or on top of the washer but put it back in your car when it is not in use.
- If you do not have a car, place the basket on top of the washer and inspect it thoroughly before putting clean laundry back into it.
- Do not set your laundry basket anywhere near the seating areas or trash cans.
- Inspect any chairs in the seating area of the laundry mat before sitting on them.
- Inspect the table used for folding laundry before placing your clean clothes on them. Better still, fold your clean laundry at home.
Bed Bugs in the Work Place

• Some jobs are more risky for encountering bed bugs than others, consider the pest control operator.

• However, there are a host of other jobs that bring people into close contact with bed bug. Think about it:
  – doctors, nurses, home healthcare and hospice workers, homeless shelter employees, school teachers, daycare workers, parole and police officers, prison wardens, firemen, ministers, priests, plumbers, electricians, movers, painters, handymen, apartment managers, hotel managers, hotel maids and maintenance personnel, taxi and limousine drivers, theater ushers, janitors........

• All should be familiar with bed bugs and on the look out for them in their day to day activities
Bed Bugs At Work

- If you belong to a profession where you are required to visit people’s homes that you know or suspect have bed bugs:
- wear dedicated clothing and shoes that you can bag up in your vehicle, to avoid taking bed bugs into another person’s home or your own.
- Be conscious of not sitting on the couch or laying your hand bag or backpack on the furniture.
- Inspect your clothing and the bottom of our shoes when you leave a person’s home, and before you get into your vehicle.
- Some professions now provide Tivec™ suits for employees that who make regular visits to client’s homes as part of their job.
Bed Bugs At Work

- Slowly but surely bed bugs are also making their way into office buildings. If you work in an office building:
- Keep your handbag and personal items in a desk drawer rather than setting them on a chair or the floor.
- Hang your jacket on a hanger in your office or cubicle. Do not just hang it on the back of your office chair.
- If you find a bed bug in your office, catch it in a plastic bag for positive identification.
- Be discrete (bed bugs can cause mass hysteria in an office) and contact the building maintenance personnel immediately.
Early Detection Tools

• Early detection is critically important to putting a bed bug problem behind you quickly and efficiently.
• If you find a bed bug in your home, don’t freak out! You don’t have time. You will need all of your rational faculties focused on the tedious bed bug elimination process.
• First, catch the bed bug if you can and preserve it in a plastic bag for positive identification. Next, try to isolate the location where the bed bug was seen.
• Next call a qualified and experienced pest management company to do an inspection.
• Comply with all of the pest managers directions on preparing your home for inspection and treatment.
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Early Detection Tools

- You may want to purchase high quality mattress encasements for your mattress and box springs. The encasements keep you from having to throw the bed away, and prevent new bed bugs from infesting the box springs.
- You may place ClimbUp™ devices under the bed and furniture legs to detect and intercept bed bugs as they attempt to climb the bed legs to feed on you.
- The mattress encasements and ClimbUp™ devices are the best methods for preventing bed bug infestations from progressing undetected.
Bed Bug Consciousness

• Please don’t be paranoid about bed bugs. But be aware that you may encounter them during your daily activities.
• Because there is currently no simple and inexpensive way to eliminate bed bug infestations, so we are seeing their populations becoming more and more widespread.
• It is for this reason that we need to develop a “bed bug consciousness” so that we can modify our behavior to avoid bringing bed bugs into our home.
What About Control Methods?

- Although bed bug treatment has been insecticide heavy in the recent past, more and more non-chemical methods are being used to supplement the pesticide products for a more integrated approach.

- Here we will review the chemical and non-chemical methods used for bed bug control.
Insecticide Basics

- The U.S. EPA is responsible for protecting people from exposure to pesticides.
- EPA has strict toxicity testing methods.
- The test results are reviewed by the EPA before a pesticide is allowed to be sold in the United States.
- Those pesticides that are not long-term environmental contaminates and that have very low mammalian toxicity will be registered, under strict conditions.
- Pesticides will have 1000-fold *margin of safety* reflected in the label directions (See the Food Quality Protection Act for more information).
- What does all this mean for bed bugs?
Insecticide Sprays

- Insecticide sprays are formulated by mixing a small volume of active ingredient (0.03%-0.5%) into a large quantity of water inside a spray tank.
- The spray is applied in cracks and crevices and along baseboards where bed bugs hide. If the bed bugs themselves are sprayed directly they will die.
Insecticide Sprays

- Sprays are also supposed to leave behind active residues (residual) to kill bed bugs after the product has dried. Unfortunately, studies have found that bed bugs are not very susceptible to dried insecticide residues. Bed bugs may have to sit on the dried residues days.

- If the spray is applied in cracks where the bed bugs rest, the dried residues have a much better chance of killing the bed bugs harboring there.
• Aerosol products are insecticides formulated with a propellant that allows them to be sprayed out of a can under pressure.
• Many types of insecticides are formulated as aerosols,
• The labels on these products may list very different directions regarding where the product can be applied.
• It is very important that pest management professionals be knowledgeable about the label directions for each product.

Aerosols work best when bed bugs are sprayed directly. However, a few aerosols leave residues that are active for several days after their application.
Insecticidal Dusts

- Bed bugs walking on dusted surfaces will become covered in the dust.
- Some dusts contain some of the same active ingredients as liquid insecticide formulations.
- The labels for insecticidal dusts allow them to be applied in protected cracks and crevices.
- Dusts can be used in wall voids to intercept bed bugs travelling from one apartment unit to another. They can be puffed in behind baseboards, electrical outlets and other locations where bed bugs like to hide.
- Dust cannot be used in locations where they would be moved on air currents.
- Dusts have strict label directions as to where they can be placed in the indoor environment.
Insect Growth Regulator: Hydroprene

- There are two products formulated with hydroprene, one is a liquid insecticide, the other is an aerosol.
- The IGR residues mimic insect growth hormones in the young bed bug’s body. These hormones cause the bed bugs to develop incorrectly. The nymphs molt, but are supposed to be incapable of reproduction as adults.
- Laboratory studies have shown that hydroprene does not sterilize bed bugs. Instead, the IGR exposure results in many bed bugs dying during or after the final molt.
- Some bed bugs that survive are still able to mate and produce one batch of eggs, even if they die afterward.
- The affect of hydroprene on a population living in someone’s apartment are still not known.
Consumer Use Products

- There are many insecticide products available for consumer use. However, most of these products contain pyrethroids.
- Bed bugs are highly resistant to pyrethroids, so efficacy is limited.
- Because the products do not work consumers over use them.
- When the first two bombs fail, they set off ten.
- Multiple bombs typically fail to kill all of the bed bugs.
• Clutter Removal
  Place clothes that are on the floor into bags for laundering.
• Remove items from under the bed, but do not move them into another room.
• Bag and throw away any items in closets that you no longer use.
• Old newspapers, junk mail, magazines, and broken electronic equipment should be bagged and thrown away.
• The pest management professional may provide specific instructions.
Mattress Covers

- Encasements for both mattress and box springs!
- Improved version has a zipper protector sewn in
- Traps bed bugs and eggs, bite proof and escape proof
Not all covers protect

Where the zipper closes and the zipper teeth are vulnerable to bed bug escape
Dissolvable Laundry Bags

- Dissolvable (GreenClean™) laundry bags are laundry bags that dissolve in the washer. You can pack your clothing and other washable belongings into the bags and put them directly into the washer without having to open the bag, or disposing of a potentially infested bag in the laundry mat.
Vacuuming

- The value of vacuuming is that it makes inspections easier.
- In large infestations, bed bug harborages are not only filled with live bed bugs, but also with dead bed bugs, molted skins, hatched egg shells, and feces.
- It is often difficult to distinguish what is alive from what is dead in a messy harborage, particularly after treatment.
- A high powered vacuum is very useful for removing this debris.
Steam Cleaning

- Steam temperature (at the bed bug) must be 135° F (54° C) or greater
- The steam head must be large
- Steam power will kill bed bugs and their eggs (115° F)
- Steaming is slow and labor intensive

Upholstery and bedding can disperse steam heat
Thermal death point 48° C
Cryonite®

- Some of the larger pest management companies have been using a new technology where bed bugs are frozen to death by being exposed to pressurized CO₂ snow at -108o F. The snow mixture is blown out a pressurized cylinder through a nozzle that forms vapors to penetrate baseboards, bedding, box springs, the furniture, other cracks and crevices where bed bugs aggregate.

- The pressurized snow freezes the cells of the bed bug killing them instantly. Similar to steam cleaning, the Cryonite® process requires patience.

- This system will not eliminate a bed bug infestation if used alone. Other control methods will still have to be used.
Diatomaceous Earth

• Diatomaceous earth (DE) is a desiccant dust made of the silica-based skeletons of microorganisms called diatoms. This dust kills bed bugs by sticking to the outside of their bodies and absorbing the wax layer that keeps them from losing their body moisture. The bed bugs desiccate and die within a couple of days.

• Do not use the pool filter DE it has been heat treated and is an inhalation hazard
Climb-Up Device

- Used for detecting small infestations (early detection)
- Prevents fed bugs from leaving the area
- Detects bed bugs that may be entering adjacent units
- Can catch enough bed bugs to reduce the population
Canine Scent Detection

- Excellent detectors for both hotels and apartments
- As of 2008 most will distinguish between live and dead infestations and can detect eggs
- Good for lawsuit defense