

3E453 – Pest Management Journeyman

Module 4, Lesson 1, Task 1 (10.2.1, 10.2.3, 10.2.4) Disease Vectors

Slide 1.1 – Introductory Slide

Slide 1.2 – Lesson Title Slide

3E4X3 Career Development Course

10.2.1, 10.2.3, 10.2.4 Disease Vectors

Slide 1.3 – Instructions

Welcome to the Disease Vectors Lesson.

- Upon completion of this lesson, you must be able to identify basic facts and principles relating to Identify, Survey, and Control measures for Disease Vectors with at least 75% accuracy.

Overview

In this section, we will cover the following topics:

- Disease Vector Identification
- Disease Vector Survey
- Disease Vector Control

Slide 2.1 – Disease Vector Identification Intro

Slide 2.2 – Disease Vector Identification

- Disease Vector
- Mosquitos
- Flies
- Mites
- Bed Bugs, Lice, Fleas
- Ticks

Slide 3.1 – Disease Vector

- Disease is the impairment of the normal state that affects the performance of the vital functions of a plant or animal.
- Vectors are organisms (such as insects) that transmit a pathogen (a bacterium or virus).
- Disease Vectors are insects that transmit diseases to living plants and animals.

- Blood sucking insects have the highest chances of mechanically transmitting diseases to humans due to the exchange of blood.

Slide 4.1 – Mosquitos

- Mosquitoes are among the most important human health pests worldwide due to their ability to transmit certain pathogens.
- Many serve as carriers (vectors) of pathogens that cause diseases such as malaria, dengue, encephalitis, yellow fever, West Nile virus, and heartworm disease in dogs.
- All mosquitoes belong to the family Culicidae, which has more than 3,200 recognized species.

Slide 4.2 – Mosquito Life Cycle – Eggs

- EGGS - white when first deposited, becoming dark within an hour or two
- There are three distinct groups:
- **Anopheles** - Lay their eggs singly on the water surface
 - Eggs float horizontally and are oval shaped
 - Usually pointed at one end and have a pair of lateral floats
 - Hatching usually takes place within 2- 3 days
- **CULEX** - Eggs are laid side by side to form a raft and often contain 100 or more eggs
 - Eggs remain afloat on the water surface until hatching
 - Hatching usually occurs in only a few days
- **AEDES** - Eggs are laid on the sides of containers or tree holes just above the water level so that when the water rises, the eggs hatch
 - Some Aedes species may survive in the egg stage for 3-5 years if flooding does not occur
 - In some cases, hatching occurs as soon as the eggs are flooded; thus, several generations per year may occur

Slide 4.3 – Mosquito Life Cycle - Larvae

- LARVAE all live in water and must obtain air from the surface or through aquatic vegetation.
- These species of mosquito will determine the position of the larvae:
- **ANOPHELES** - Lie parallel to the water surface
- **AEDES AND CULEX** - Hang head down with only the tip of the air tube penetrating the surface of the water
- Four developmental instars or growth stages require 5 to 15 days to complete.

Slide 4.4 – Mosquito Life Cycle - Pupa

- PUPA lives in water and is very active. It does not feed but still must come to the surface for air.
- Pupa is enclosed in a sheath, which is lighter than water.
- On the upper surface is a pair of respiratory organs called trumpets.
- Abdomen consists of eight freely movable segments with a pair of paddles at the tip.
- Pupal stage lasts from one day to a few weeks.
- When the Pupal stage ends, the pupal skin breaks, the adult works its way out, crawls onto the water surface, and is soon ready to fly away.

Slide 4.5 – Mosquito Life Cycle – Adult

- ADULT mosquitos are small fragile insects with a slender abdomen, one pair of narrow wings, and three pairs of long slender legs.
- Depending on the species, it varies in length from slightly over 1/6 inch to about 1/2 inch.
- Click next to learn more about the three body regions.

Slide 4.6 – Mosquito - Head

- HEAD - large compound eyes, one pair of antennae, one pair of Palpi, and a proboscis
- Entomologists believe the antennae serve as organs for hearing and smelling
- Palpi have five segmented structures originating at the lower front margin of the head near the proboscis and they are used for taste
- Proboscis projects downward and forward from the lower front margin of the head
- Consists of a labium (a sheath like structure) enclosing a group of six stylets
- Labium serves as a protective sheath for the stylets but does not enter the wound when the mosquito is biting
- Stylets penetrate the skin of the host animal, forms a small duct through which saliva is injected and liquid is drawn
- The mouthparts of the male are not strong enough to pierce human or animal skin, so they feed on plant juices instead of blood

Slide 4.7 – Mosquito - Thorax

- THORAX - middle region of the body that bears the wings and legs
- Upper surface of the mesothorax or mesonotum is covered with coarse hairs and used for identification purposes.
- Long slender legs arise from the lower sides of the thorax.
- Legs are covered with scales of varying colors, forming patterns which are often useful in separation of species.
- Wings- long and narrow, vein-like appearance
- Veins- covered with scales, often with varying colors; forms definite
- Halteres- small knobbed like structures found behind and below wings
- Halteres serves as a balancing organ

Slide 4.8 – Mosquito - Abdomen

- ABDOMEN - cylindrical in shape with 10 segments
- 8 are readily visible
- 9th and 10th segments are modified for reproductive functions

Slide 4.9 – Common Anopheles in the CONUS

ANOPHELES PUNCTIPENNIS

- The Anopheles punctipennis is widely distributed throughout the United States
- Although all the anopheles' mosquitoes have a similar general appearance, this mosquito has wings conspicuously marked with spots of pale and dark scales; the palpi are entirely dark.
- Outdoors, it is a vicious biter but apparently does not enter houses as readily as Anopheles quadrimaculatus and Anopheles freeborni.

- Anopheles punctipennis breeds in a wide variety of habitats; larvae may be found in rain barrels, grassy bogs, spring pools, swamps, and along margins of streams.
- They seem to prefer cool water and are the first Anopheles species to hatch in the spring.
- In the South, they are most abundant in the spring and fall, but are found throughout the summer in the northern states.

Slide 4.10 – Common Aedes in the CONUS

- The Aedes aegypti is a small dark species; The lyre-shaped, silvery-white lines on the thorax and the white bands on the tarsal segments easily identify it.
- It is a vector of urban yellow fever and dengue, and a pest, when present in large numbers.
- Aedes aegypti is essentially a tropical species, probably introduced into the Western World from Africa.
- This is a thoroughly domesticated mosquito and breeds almost exclusively in artificial containers in and around human habitations.
- The females lay their eggs singly near the water just at the margin or on the sides of the container above the waterline.
- They prefer human blood to that of other animals and readily enter homes to find suitable hosts.
- Aedes aegypti bites mainly in the morning and late afternoon. It attacks quietly, preferring to bite around the ankles, under shirt sleeves, or on the back of the neck.

AEDES SOLICITANS

- Because it transmits eastern equine encephalitis (EEE), the Aedes sollicitans is the most important of the salt-marsh mosquitoes. In addition, it is also one of the most severe pest mosquitoes known.
- It is found along the Atlantic and Gulf coastal plains from Maine to Texas and in many inland areas where brackish water is available.
- Adults can have a golden-brown color on top of the thorax and a longitudinal stripe of white or yellowish-white scales on the abdomen.
- The proboscis and tarsi also have wide pale bands
- Females lay their eggs singly on the mud of salt marshes, where they remain until flooded by high tides or rains.
- Oviposition generally occurs in marsh areas that are not covered by daily tides.
- The females usually use potholes and depressions of various sizes, but they may also lay eggs over rather extensive level areas.
- Eggs must stay dry at least 24 hours before they can hatch. After drying for a week or two, the eggs will hatch in a few minutes when water covers them.
- Aedes sollicitans adults are strong fliers and often migrate in large swarms from marshes to cities and towns many miles away.
- They very commonly fly 5 to 10 miles and may travel up to 40 miles or more.
- Migratory flights begin just before dark and may include tremendous numbers of mosquitoes.
- They rest among the grasses during the day but will readily attack anyone who disturbs them

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AEDES NIGROMACULIS

- The *Aedes nigromaculis* is a medium-sized dark mosquito with a longitudinal line of yellowish-white scales on the upper surface of the abdomen.
- It is an important pest mosquito throughout the western plains extending from Minnesota west to Washington and south to Texas and Mexico.
 - In recent years, it has attained prominence as a pest in the irrigated pastures of the west, especially in California.
 - The adult is a severe biter and attacks readily. It will bite during the daytime but is most active in the evening.
 - It is a strong flier and may migrate several miles from its breeding ground.

AEDES VEXANS

- The *Aedes vexans* (floodwater mosquito) is a medium-sized brown mosquito with narrow rings of white scales on the hind tarsi and a V-shaped notch on the middle of each band of scales on top of the abdomen.
- This is probably the most widely distributed *Aedes* species in the United States and the most abundant and troublesome mosquito in many areas.
- You can find this species in every state and it is a major pest in most of the northern United States.
- The *Aedes vexans* breeds in rain pools, floodwaters, roadside puddles, and practically all temporary bodies of fresh water.
- Adults migrate long distances (5–10 miles) from their breeding ground.
- They are vicious biters and are especially annoying at dusk and after dark.

AEDES TAENIORHYNCHUS

- The *Aedes taeniorhynchus* is also known as the black salt-marsh mosquito.
- It has cross bands of white scales on top of the abdomen and white rings on the proboscis and tarsi.
- It is found on the coastal plains from Massachusetts to Texas and on the Pacific coast in southern California.
- This is the most abundant and troublesome salt-marsh species along the south Florida coast.

AEDES ALBOPICTUS

- The *Aedes albopictus* is also known as the tiger mosquito or Asian tiger mosquito.
- This species was recently introduced into the CONUS from Southeast Asia via used tires. As of 1991, it was established in 160 counties in 18 states.
- *Aedes albopictus* resembles *Aedes Aegypti* except that the lyre-shaped markings on the thorax are replaced by a stripe of silvery-white scales.

- It is a forest-dwelling species and has adapted itself to urban environments. In the United States, it is found mainly in artificial containers, especially tires.
- In Southeast Asia, it is a major vector of dengue fever.
- As of 1991, isolations of EEE and Potosi viruses have been made from this mosquito in the United States.

Slide 4.11 – Common Culex Species Found in the CONUS

Culex Pipiens Quinquefasciatus

- We group the closely related *Culex pipiens* and the *Culex quinquefasciatus* complex.
- We do this because it is difficult to distinguish between these species.
- The *Culex pipiens* is known also as the northern house mosquito.
- In contrast, the *Culex quinquefasciatus* is known as the southern house mosquito.
- The mosquitoes of the *Culex pipiens quinquefasciatus* complex are brown and of medium size with cross bands of white scales on the abdominal segments. They lack any other prominent markings.
- The *Culex pipiens* (the northern house mosquito) occurs throughout the northern United States extending as far south as Georgia and Oklahoma.
- The *Culex quinquefasciatus* (the southern house mosquito) is in all the southern states from coast to coast and as far north as Nebraska, Ohio, Illinois, and Iowa.

Common Culex Species

- The house mosquitoes are the most common mosquitoes in homes and their habit of singing is extremely annoying. They are important vectors in urban epidemics of St. Louis encephalitis.
- *Culex pipiens* and *Culex quinquefasciatus* breed in rain barrels, tanks, tin cans, and most other artificial water-holding containers available.
- Other important breeding places are storm-sewer catch basins, street gutters, polluted ground pools, cesspools, open septic tanks, and effluent drains from sewage disposal plants.
- These species do not migrate far except when great numbers are being produced.
- Ordinarily, when adults are found, larvae will be nearby.
- Adults are active only at night.
- They are typically found during the day in and around houses, outbuildings, and other shelters.

Culex Tarsalis

- The *Culex tarsalis* is also known as the western encephalitis mosquito.
- This is a dark, medium-sized species with a broad white band at the middle of the proboscis and white bands at each of the tarsal segments.
- The white markings on the femur are conspicuous and useful in identification.
- This species is the main vector of western and St. Louis encephalitis in the western United States.
- *Culex tarsalis* is essentially a rural mosquito. It is widely distributed west of the Mississippi River, including southern Canada and northern Mexico; however, it is most abundant along the Pacific Coast.
- Females lay their eggs in a wide variety of water situations such as canals, ditches, ground pools, effluent from cesspools, cans, barrels, catch basins, and ponds.

- Eggs are laid in rafts and usually hatch within 2 days.
- Larval and pupal states develop rapidly, and breeding is continuous during warm weather.
- Adults usually stay within a mile of the breeding site.

Culex Nigripalpus

- The Culex nigripalpus mosquito species is mainly a tropical mosquito but occurs as far north as Kentucky and North Carolina.
- It is very common in Florida where it is a pest in rural areas.
- Larvae are found in ditches and grassy pools.
- It is also important as a vector of St. Louis encephalitis.

Slide 5.1 – Flies

Slide 5.2 – Flies – Overview

- Flies have been intimate companions of mankind for eons and have annoyed us and plagued us with their vicious bites. Fly larvae have infested human flesh, as well as that of domestic animals and have attacked and destroyed our crops.
- Flies can transmit human diseases such as Oropouche fever, African sleeping sickness, Oncho. Flies can affect individual efficiency and productivity by constant annoyance.
- Transmit Diseases - Pathogenic organisms (disease causing organism) are picked up by flies from garbage, sewage, and other sources of filth and transferred to humans in five ways:
 - On their mouthparts
 - Through their vomit, cercariae, and Leishmaniasis, which have caused millions of deaths.
 - On their body hairs
 - On the sticky pads of their feet
 - Through their feces

Slide 5.3 – Flies Life Cycle - EGG

- EGG - Some species retain the eggs within the body until hatching giving birth to larvae

Slide 5.4 – Flies Life Cycle – Larva

- LARVA - Often referred to as "Maggots"

Slide 5.5 – Flies Life Cycle – Pupa

- PUPA - enclosed in a tough skin; immobile

Slide 5.6 – Flies Life Cycle – Adult

- ADULT - Adult flies have three distinct body regions:
 - Head - Large compound eyes
 - One pair of antennae
 - Mouthparts which are adapted for:
 - Piercing
 - Sucking
 - Rasping
 - Sponging
 - Thorax - Consists of three segments, each bearing a pair of legs:
 - Prothorax
 - Mesothorax - Single pair of wings

- Metathorax - Halteres (balancing organs)
- Abdomen - Composed of 4 to 9 segments and the genital organs

Slide 5.7 – Common Biological Characteristics

- Breeding Media - Any warm moist organic material (animal manure)
- Resting Places - Show a preference for edges
- Flight - Travels at 4 mph up to 6 miles in distance
- Temperature - Flies are inactive at temperatures below 45° F and killed by temperatures slightly below 32° F and above 112° F
- Light - Flies are phototropic (attracted to light sources)
- Wind - Flies are sensitive to strong air currents and are usually not active on windy days
- Natural Enemies:
- Reptiles
- Birds
- Mammals

Slide 5.8 – Important Species

Houseflies

- 1/4 to 2/3 of an inch long
- Dull thorax / Dull abdomen (Dull/Dull)
- Thorax has four longitudinal dark stripes
- Abdomen is pale
- Fourth wing vein is sharply angled ending before the wing tip
- Medical Importance:
- Houseflies transmit many human enteric diseases, such as dysentery, cholera and typhoid fever
- The housefly has a wide flight range and varied food tastes, and because the female is naturally attracted to filth where she can lay her eggs, the presence of flies in dining facilities or homes is dangerous as well as unsightly.

Little Houseflies

- 9/32 of an inch long
- Dull thorax/Dull abdomen (Dull/Dull)
- Three dark longitudinal stripes on thorax
- Fourth wing vein is straight

Stable Flies

- 13/64 to 9/32 of an inch long
- Dull thorax with 4 dark longitudinal stripes and a pale spot behind the head
- Dull abdomen with dark spots
- Dull / Dull
- Fourth wing vein is gently curved
- 5/16 of an inch long
- Dull thorax /Dull abdomen
- Fourth wing vein gently curves and ends at about the wing tip
- Breed in decaying animal and vegetable matter
- Commonly found in scattered garbage

False Stable Flies

- 9/32 of an inch long
- Dull thorax/Dull abdomen (Dull/Dull)
- Three dark longitudinal stripes on thorax
- Fourth wing vein is straight

Dump Flies

- 5/16 of an inch long
- Shiny thorax / Shiny abdomen and black in color
- Found near garbage disposal sites
- Second and third stages of larvae are predaceous on other fly larvae

Flesh Flies

- 2 to 3 times larger than the house fly
- Dull thorax /Dull abdomen
- Three distinct stripes on thorax
- Checkerboard pattern on the abdomen with a reddish-brown tip at the end
- Fourth wing vein is sharply angled and ends before the wing tip
- Larvae found in meat, cheese, fish, and other foods left exposed

Bottle Flies and Blow Flies

- GENERAL CHARACTERISTICS - Both flies lay their eggs upon animal carcasses and meat products, causing them to swell "Bottle" or "Blow" with maggots, giving them their names.

Bluebottle Flies

- 25/64 to 19/32 of an inch long
- Dull thorax and shiny metallic blue, green, or purplish abdomen (Dull/Shiny)
- Fourth wing vein sharply angled

Black Blowfly

- Shiny black thorax and abdomen with a metallic - blue - green luster
- Eggs are laid in animal carcasses or in the edge of wounds in living animals

Cluster Fly

- Clustery fly is slightly larger than the housefly
- Its abdomen is slightly metallic reflection beneath a dusty checkerboard pattern.
- Tufts of yellowish hairs are on the side of the thorax
- They accumulate in closets, attics, and unused rooms to hibernate

Slide 5.9 – Other Flies of Importance**Filter Flies**

- Small fuzzy fly with hairy wings
- Wings are held roof-like over the body

Sand Flies

- Seldom larger than 5' long
- Wings are elevated and spread to form a "V"
- Wings and bodies are densely covered with hairs
- Antenna are long and slender with 12 to 16 segments
- Mouthparts are long and adapted for bloodsucking
- Found in the Far East, Middle East, North Africa, and Central and South America

- Adults have been found most often in hollow trees or in rodent burrows

MEDICAL IMPORTANCE

- Transmit organisms causing Sandfly Fever, Leishmaniasis (Invaders of body tissues), Oroya Fever.
- Visceral leishmaniasis (Kala-azar) and cutaneous leishmaniasis (Oriental sore) are other diseases sand flies transmit to humans in areas where US military forces frequently operate in contingency locations.

Black Flies (Buffalo Gnats)

- 5/64 to 13/64 of an inch long
- Stout bodied with short antenna
- Humped thorax which gave common name of "Buffalo Gnat"
- Eggs are laid in or near flowing water
- Larvae and Pupae found attached to submerged rocks, sticks, or vegetation
- Heavy attacks may be fatal

MEDICAL IMPORTANCE

- Several species are vectors of Onchocerciasis (River Blindness)

Horse Flies

- Stout, strong flyers
- Large and brown
- Wingspan exceeds two inches
- Large, prominent, brilliantly colored eyes
- Short, three segmented antenna

MEDICAL IMPORTANCE

- Inflict painful bites which can cause blood loss in animals
- Vector of several diseases such as Loa, or "Eye Worm"

Slide 6.1 – Mites

- Medical Importance
- Mite Life Cycle
- Types of Mites

Slide 6.2 – Medical Importance

- Mites are important because they cause or are involved in:
- Scabies or mange like conditions
- Dermatitis is an irritation of the skin
- Infestations of the lungs, intestines, or urinary passages
- Encephalitis is an inflammation of the brain which can cause death
- Mites vector Rickettsialpox, which is a disease of mice that is transmitted to people by mites

Slide 6.3 – Types of Mites

Chiggers

- Also known as red bugs
- Can cause intense itching and small reddish welts on the skin
- Larva is the parasitic stage that feeds on humans and animals

- Nymphs and adults do not feed on people; they feed on eggs or young of various arthropods
- The larva is orange-yellow or light-red in color, and has six legs

Follicle Mites

- Live exclusively in human hair follicles
- Small, about 3/10 of an inch long, worm-like, with rudimentary legs

House Dust Mites

- Small, adults are about 5/10 of an inch long and the immatures are even smaller
- Globular in shape, clear to creamy white in color, with hairs on their legs and body
- Not parasitic nor are they capable of biting or stinging humans
- Significance as pests is due to the powerful allergens contained in the mites, their cast skins, fecal material and secretions

Scabies Itch Mites

- Scabies is the most common and important condition resulting from mite infestation of humans
- Burrow and produce tunnels one centimeter or more in length just below the surface of the skin, in which they lay eggs
- Mites are believed to feed on skin and secretions

Red Poultry Mites

- A threat to birds used for meat and egg production
- They are found in many areas including Europe, Japan, China, and the United States
- Lives or feeds on exterior of the host that typically feeds at night
- Lay eggs where they hide, in areas such as cracks, crevices, and litter
- Females lay eggs in clutches of four to eight, generally laying around 30 eggs in their lifetime
- After hatching, the six- legged larvae are sluggish, and molt after one day
- The Red poultry mite is a natural vector of encephalitis among chicken, but are known to vector it to humans

Tropical Rat

- Live in the nest material of rodents or birds, feed on the blood of the animal, and then return to the nest material when they are done feeding.
- Humans can become a target for the mite's next blood- meal if the rodent or bird nests are found in housing structures

Slide 6.4 – Life Cycle

- LIFE CYCLE - Gradual Metamorphosis (Egg, Larvae, Nymph, and Adult):
- Life cycle is very short usually 2 to 3 weeks
- Increase very rapidly during favorable conditions
- Physical Characteristics
- Usually less than 1/8 of an inch in length
- Long body hairs on many species
- No Haller's organ present
- Smooth hypostome

- Four pair of legs

Slide 7.1 – Bed Bugs, Lice, Fleas

Slide 7.2 – Bed Bugs

- Some people are not adversely affected by the bites of bed bugs; in others the irritating salivary secretions cause whitened hard swellings or welts.
- Excessive bites over a period may result in nervousness, anemia, insomnia, and general disability.
- Bed bugs have not been incriminated in the natural transmission of any disease, but experimentally, they can transmit several disease organisms.
- Their main importance is that they are bloodsucking pests.
- Bed bugs undergo incomplete metamorphosis: Egg, Nymph, Adult.
- Their life cycle from egg-to-egg may take 4 to 5 weeks under favorable conditions 83 to 90 °F.
- Females attach their 1 mm-long, cylindrical (about four times as long as their diameter), pearly-white eggs to any nearby surfaces, usually in crevices (harborages), where the active bugs hide in groups or clusters.
- Adult bed bugs are about 5–7 mm (3/16 to ¼ inch) long, broadly oval, flat, brown to reddish-brown true bugs, with a 3-segmented beak, 4-segmented antennae, and vestigial wings.
- They have very thin, vertically flattened bodies covered with short, golden-colored hairs.
- They give off a distinctive “musty-sweetish” odor, due to certain “alarm” chemicals that are produced by glands in their ventral thorax.
- Abdomen tips of males’ are usually pointed and those of females are more broadly rounded.
- Young nymphs resemble the adults, except for size; they molt five times before becoming adults.
- Nymphs need at least one blood meal of adequate volume in each active life stage (instar) to develop to the next stage and to reproduce.
- They must have a blood meal between each molt.
- Bed bugs will readily travel 5 to 20 feet from an established harborage to feed on a host.
- Although they seem to prefer humans, they readily feed on birds, rodents, or other mammals.
- Bed bugs are nocturnal but will seek hosts and feed in full daylight if hungry.

Slide 7.3 – Fleas

- Fleas carry diseases in many parts of the world. They are a carrier of bubonic plague and flea borne typhus from rats to humans.
- Fleas attack humans and domestic animals; they serve as intermediate hosts for some species of dog and rodent tapeworms that occasionally infest people.
- Fleas go through complete metamorphosis.
- Eggs - deposited among the hairs or feathers of host
- Smooth
- spherical to oval

- light colored
- large enough to be seen by the naked eye
- Not sticky or attached to the host
- Hatch in 2 days to several weeks depending on the temperature and humidity
- Larva - Small 13 segmented worm - like without legs, blind, whitish, with chewing mouthparts.
- Can be found in floor cracks and rugs, kennels, and cat boxes
- Feeds on organic matter, including adult flea feces
- Pupa - Cocoons of fine silk encrusted with debris and sand, which acts as insulation and camouflage.

Adult

- Small, varying from 3/64 to 23/64 of an inch Wingless
- Siphoning mouthparts
- Compressed laterally
- Spines directed towards the posterior end
- The flea is a narrow insect compressed laterally with backwardly directed spines, which adapt it for moving between the hairs and feathers of mammals and birds.
- Genal and Pronotal combs (present or absent) such as:
- No Genal or Pronotal Combs
- Stick Tight Flea
- Oriental Rat Flea
- Human Flea
- Pronotal Comb and No Genal Comb:
- Ground Squirrel Flea
- Northern Rat Flea
- Pronotal and Genal Comb Present
- Mouse Flea
- Cat Flea
- Dog Flea
- Teeth position of genal comb
- Shape of the Head - May be rounded or angled
- Length of labial palps / lips of mouth
- Position of ocular bristle /eyebrow
- Number and position of plantar bristles / hair on feet
- Has very strong legs used to jump on or to host

- Shape and color of spermatheca in female specimens
- Important flea species
- Oriental rat flea - principal vector of bubonic plague and murine typhus
- Dog flea
- Cat flea
- Human flea

Slide 7.4 – Lice

- The body louse is involved in epidemics of:
- Louse borne typhus
- Trench fever - An acute relapsing fever
- Relapsing fever - An infectious disease marked by chills and fever
- Severe infestation may lead to scratching, secondary infections and scarred, pigmented skin conditions known as pediculosis
- Lice undergoes gradual metamorphosis: egg, nymph, and adult.

HEAD

- Head Louse is 3/64 to 5/64 of an inch long
- Found in hair and on scalp
- Most prevalent on the back of the neck and behind the ears

BODY LOUSE

- 5/64 to 5/32 of an inch long
- Grayish white in color
- Generally, 10 to 20 percent larger than head louse
- Found on the inner surface of clothing next to the skin

CRAB LOUSE

- 1/32 to 3/64 of an inch long
- Grayish white with a short abdomen
- Found on hairs in the pubic areas
- They may be found on hairy areas of the chest and armpits

Slide 8.1 – Ticks

- Medical Importance
- Life Cycle
- Biological Characteristics
- Common Hard Ticks
- Soft Ticks
- Common Soft Ticks

Slide 8.2 – Medical Importance

- Ticks are known to spread various deadly diseases to people.
- Their bites are irritating and if they are removed forcibly, the mouth parts frequently remain in the skin resulting in a sore, an infection or blood poisoning.
- Rocky Mountain Spotted Fever is an acute disease.

It's characterized by :

- Chills

- Fever
- Prostration (physical or mental exhaustion)
- Pains in muscles and joints
- A red to purple eruption
- Transmitted by the bite of a wood tick

Tularemia

- Also known as rabbit fever
- A plague-like disease
- Transmitted to humans from rabbits or rodents
- First occurred in Lyme, Connecticut in 1975
- Primary vector is the Ixodes dammini (deer tick)
- Symptoms can be severe; the disease can lie dormant in the body for years, even decades.
- Acute headaches
- Serious nervous system impairment
- Symptoms resembling rheumatoid arthritis, the most severe form of arthritis
- Expanding red rash on or near the tick bite
- Low grade fever
- Abdominal and joint pain
- Dizziness
- Stiff neck
- Alpha-gal is a sugar molecule found in most mammals.
- A bite from a lone star tick or a blacklegged tick may produce an allergic reaction, from mild to life-threatening, to products containing Alpha-gal, including:
 - Red meat
 - Gelatin
 - Some medications
 - Vaccines
 - Cosmetics
 - Milk products
- Products made from fish, reptiles, birds, or humans are not affected by Alpha-gal .syndrome.

Slide 8.3 – Life Cycle

- EGG
- Hard Ticks
- Feed (receive a blood meal from the host) once
- Drops to the ground
- Lays a large (1,000) batch of eggs
- Dies

Soft Ticks

- Feed several times
- Lay 20-50 eggs after each blood meal

LARVA (SEED TICK)

- Only six legs in this stage

- Cannot distinguish sex at this stage

NYMPH

- Eight legs
- No genital (sex) openings
- Hard Ticks - have no instars (Growth Stages)
- Soft Ticks - may have several instars

ADULT

- Sex is distinguishable
- Head, thorax, and abdomen are fused together, forming one body region
- No antennae are present
- Toothed Hypostome
- Bears many rows of re-curved barbs
- These anchor to the skin of the host
- Haller's Organ
- Located at the end of front right leg
- Senses CO₂, which aids in finding a host

Slide 8.4 – Biological Characteristics

- The hard dorsal shield or scutum is located behind the capitulum (mouthparts).
- It gives the illusion of a false head.
- Females dorsal (top) shields are much smaller than males.
- Body is tapered towards the head
- Hard ticks have mouthparts visible from above.
- Vector of typhus and tularemia
- Females easily recognized by a silver-white spot at the tip of the scutum
- Males have pale marking on scutum
- In the southeastern United States, the Lone Star tick infests deer, cattle, dogs, and birds, and will readily bite people while in the larval, nymphal, and adult stages.
- Its bite is quite painful and may itch for a long time.

Slide 8.5 – Common Hard Ticks

- American dog ticks (*Dermacentor variabilis*), as well as other species, are attracted to the scent of animals, so they are most numerous along roads, paths, and trails.
- This species is the principal vector of tick-borne typhus in the central and eastern United States.
- The American dog tick is also widely distributed east of the Rocky Mountains and the Pacific coast.
- Dogs are its preferred host, although it feeds readily on many large mammals.
- Adults are commonly found in grass and other low vegetation.
- Males remain on the host for an indefinite time period, alternately feeding and mating.
- Females feed, mate, become engorged, and drop off to lay several thousand eggs.
- Larval ticks are very small and have six legs.
- The Rocky Mountain wood tick (*Dermacentor andersoni*) is common in the Rocky Mountain States and in southwestern Canada.

- Larvae and nymphs attack small mammals, and adults obtain their blood meals from large mammals, including people.
- This tick also is a vector of Rocky Mountain spotted fever and is the principal vector of the disease within its range.
- It closely resembles the American dog tick, but adult wood ticks in general have paler coloring and larger goblets (circular markings) on the spiracular plates.
- Deer tick is a common name attached to these two different genera of ticks: *Dermacentor albipictus* and *Ixodes*.
- *Dermacentor albipictus*, also called the winter tick or the elk tick, is widely distributed in North America.
- This one-host tick does not attack in the summer; instead, the larvae seek a host after colder temperatures occur.
- Large populations may cause the death of deer and elk through blood loss and subsequent loss of vitality.
- People are normally attacked only when they are dressing or otherwise handling infested game animals.
- *Ixodes* - In the eastern two-thirds of the United States, members of the genus *Ixodes* are also commonly called deer ticks.
- They are the principal vectors of Lyme disease within their respective areas.
- Lyme disease is a spirochete infection transmitted by the bite of three species of *Ixodes* ticks: *Ixodes dammini*, *Ixodes pacificus*, *Ixodes scapularis*.
- Dogs are the principal host of the brown dog tick (*Rhipicephalus sanguineus*), but it also attacks numerous other animals.
- It is probably the most widely distributed tick species in the United States.
- Fortunately, it only occasionally attacks people.
- It transmits Boutonneuse fever in the Mediterranean area and Rocky Mountain spotted fever in Mexico.
- In the United States, it also a vector of malignant jaundice to dogs.

Slide 8.6 – Soft Ticks

- Do not possess a scutum or a dorsal shield present.
- Their mouthparts are beneath the anterior end of the body and are not visible from above; Capitulum (mouth area) is covered by the body.
- The principal hosts are birds, domestic animals, bats, and small mammals.
- An adult female lays her eggs following a blood meal, producing 500–1,000 eggs in her lifetime.
- Some species resemble bed bugs in their habits of feeding at night and hiding during the day.

Slide 8.7 – Common Soft Ticks

- From a medical standpoint, the relapsing fever tick (*Ornithodoros* spp.) is the most important genus of the soft tick family.
- The average person seldom sees relapsing fever ticks since they are mainly “nest ticks.”
- They can survive starvation for months or even years.

- The fowl tick (*Argas persicus*) is a vector of fowl spirochetosis. It is commonly called the blue bug.
- The fowl tick feeds at night and become engorged in less than an hour. After feeding they seek shelter in cracks and crevices where females deposit their eggs.
- The eggs hatch in about 2 weeks, and the six-legged larvae find a host and attach themselves.
- After feeding for about 5 days, the larvae drop off, molt, and become nymphs. The nymphs feed, molt, and go through two or three stages before they become adults.
- As adults, they readily attack people but do not usually transmit human diseases. On occasion, people have been bitten and contracted relapsing fever.
- Like the relapsing fever tick, these ticks may live for months or years without blood, awaiting an opportunity for a blood meal.
- The spinose ear tick (*Otobius meгинi*) is a soft tick that gets its name from the habit of larvae and nymphs to infest the ears of cattle, horses, mules, and so forth, and occasionally people.
- This is a one-host tick, and all stages feed on the same host.
- The rodent tick (*Ornithodoros hermsi*) is a common rodent parasite and a known vector of relapsing fever.
- It is commonly found along the Pacific coast and Rocky Mountain region of the United States.
- Larvae can expand to three times their normal size after a blood meal and appear bright red. Consequently, rodent tick larvae are sometimes mistakenly referred to as “strawberry seed insects.”

Slide 9.1 – Survey Principles

Slide 9.2 – Disease Vector Survey Principles

- Pest surveys are essential to determine the species present, their abundance, and their potential as disease vectors, and to collect enough information to base a pest management program on.
- Surveys should be a continuing part of the pest management program to evaluate the effectiveness of pest management actions.
- Types of surveillance programs:

Baseline

- Conducted to determine the types of vectors and pests occurring in the area of operations, their respective breeding sites or source habitat, and seasonal activity patterns.

Operational

- Data collected in an operational survey are used specifically to aid pest management personnel in making decisions on when to start or stop control measure.
- Operational survey data is compared to baseline data and the decision to start control or management

Specific

- Surveys conducted when a specific vector or pest species is targeted for surveillance beyond that of the baseline or operational surveys.
- Example: a survey for bed bugs in a dwelling where the inhabitants are demonstrating symptoms of parasitism by these insects. The active is based on this comparison.
- Surveys also help determine the effectiveness of past management actions and anticipate increases or decreases in operations relative to changing pest populations.
- One main concept to focus on regarding surveying for disease vectors is consistent trapping and data collection.
- If your trapping or surveying is inconsistent, your results will vary and not represent the best data needed to determine required control methods.
- Example: Set light trap out every day at same time for a week. Check the next day at the same time and annotate data.
- In this lesson, you will learn how to conduct surveys for multiple disease vectors.
- You should reference AFPMB TG 48, Contingency Pest and Vector Surveillance, for equipment and techniques that can be employed for vector surveys.

Slide 9.3 – Mosquito Survey Techniques

Resting Counts

- Accomplished by collecting mosquitoes from places where they rest when they are not actively seeking a blood meal.
- Can be collected using an aspirator, small net or collection device.
- Normally useful in areas that cooler and darker than general surroundings and in undisturbed areas out of strong wind currents.
- Areas near breeding places or places where preferred hosts congregate are the best focus areas
- Areas where water can build up is a great breeding course for any mosquito type
- Example areas:
- Near slow running water, drainage ditches, culverts,
- Animal pen Using light traps is probably the easiest and most effective way to survey and collect mosquitoes.
- Many species are attracted to light and make it much easier to collect a large number of species within a given area.s, barns, chicken houses, outdoor toilets, tires, kids play toys
- Most common and appropriate type of light traps for use in operational environments are the CDC and SSAM fitted with incandescent (white) light or black light; New Jersey light traps can also be used but require a permanent electrical source.
- Traps should be placed within four feet of the ground and fitted with a protective rain shield if weather conditions might produce precipitation.
- Ensure trap and battery source are secured to prevent them from being damaged from other animal or by weather conditions such as wind and rain.
- To enhance effectiveness, carbon dioxide (CO₂) is used to attract mosquitos that may not be attracted to light.
- Dry ice is a suitable CO₂. it can be placed in an insulated container such as a small cooler hung from or around the trap to attract mosquitoes.
- Typically, only blood-feeding insects are attracted to CO₂ which helps only attract those that are blood suckers as opposed to non-target pests.

- Light traps are most effective when placed around where the mosquitoes are located such as any areas with standing water or where hosts are located.
- Proper surveillance and identification of mosquito larvae is crucial in determining the species present and potential control efforts.
- Breeding sites where larvae and pupae could be found could include tree holes, clogged rain gutters, catch basins and other artificial containers, temporary pools, roadside ditches, ponds, swamps and marshes.
- Many of times and in high mosquito populations, it is very easy to see larvae swimming around in a water source.
- The ideal method for larvae and pupae surveys is to find a water source and use a dipper to collect water/sample water for the presence of larvae.

Slide 9.4 – Fly Survey Techniques

- There are number of different methods used to survey and determine a specific fly species such as fly traps, fly grills, sticky traps, and fly strips.
- Many of these methods will provide minimal control methods while also allowing you to identify what fly species is present

Insect Nets

- Used for a quick survey around open dumps or disaster areas
- Fly Traps

Baited Traps

- Used to determine the species and relative population.
- Normally a container with an attractant and funneled lid so the flies cannot escape once they enter the trap.

Fly Cones

- Primarily used to collect live specimens
- Made of screen wire and placed over a natural attractant, thus trapping flies beneath it

Fly Frill survey

- Requires a high degree of familiarity with fly identification
- Allows an individual to count how many times a fly lands on a given surface over a specific time period

Slide 9.5 – Mite Survey Techniques

- Place dark-colored construction paper, paper plates, rigid plastic or similar objects are placed on the ground in mite habitat such as grassy or bushy areas with high rodent population.
- The plates have no attraction but makes it much easier to see the mites as they may crawl over the plate.
- Set plates out and check periodically within a given hour.
- Make sure to check both sides of the plates and look very closely as mites are extremely small and may not be seen to the naked eye
- Another way to inspect for mites to trap the host such as a rodent and examine them for presence of mites.

Slide 9.6 – Bed Bugs

- A bed bug infestation is usually revealed through:

- Finding live bugs or signs, dark fecal deposits or lighter rusty spots.
- On bed linens or in harborages.
- Detecting eggs or cast skins in harborages.
- Near feeding sites, noting where and when alleged victims have been bitten.
- Smelling the bugs' characteristic odor
- Bed bugs are likely to be found in the tufts, seams and folds of mattresses and other bedding coverings.
- In areas of heavy infestation, bed bugs can be found in crevices in and around the bed in floor cracks, under carpets, behind loose wallpaper or wall pictures, head board and similar structures.
- Surveillance should include checking any place that offers protection, such as areas behind baseboards, under loose rugs or wallpaper, and bedding materials.
- Certain pyrethrin-based flushing agents may help stimulate the bugs to move around, making them easier to detect where populations are limited.
- The Armed Forces Pest Management Board Technical Guide 44, Bed Bugs—Importance, Biology, and Control Strategies should be referenced and used as a tool for bed bug surveys and surveillance programs.

Scent Dogs

- Dogs trained specially to detect bed bugs and possible viable eggs

Traps

- Pitfall traps, barriers and harborage mimicking devices are used to intercept bed bugs as they travel around the bed or host

Slide 9.7 – Lice

- Body lice are always a threat when large numbers of people are thrown together in close proximity such as contingency and training environments.
- They will spread rapidly from infested to un-infested people, and, if epidemic typhus is introduced, there is potential for an explosive epidemic.
- Pest Management personnel are not permitted to inspect patients; trained medical personnel are the only ones authorized to inspect an individual for lice.
- Pest Management expertise should only be used to identify the insect or louse present.

Slide 9.8 – Fleas

- Fleas are normally associated with rodents in the wild, and can be recovered from rodent burrows by swabbing.
- The burrow swab should be inserted into the rodent hole, then removed slowly, while rotating the handle to ensure you are swiping all areas of the burrow.
- Fleas in the rodent hole will be briefly trapped in the folds and fibers of the cloth; fleas can be removed with forceps and placed in a vial of alcohol for subsequent identification.
- Another method is to take many 4X4-inch squares of cloth to the field, and place each piece of cloth positive for fleas in an individual zip lock bag for removal after the fleas have been refrigerated or frozen to incapacitate them.

- Host trapping is a great tool used to assess local flea populations, particularly if the host nest can be sampled and their contents extracted with Berlese-Tullgren funnels.
- Once the host is caught or captured, you would then inspect the host for fleas.

Slide 9.9 – Ticks

- The Armed Forces Pest Management Board Technical Guide 26, Tick-Borne Diseases: Vector Surveillance and Control.
- There are several standard methods that can be used to determine the number and types of ticks in a given area.
- Whichever the method, it is very important that each survey be applied consistently to ensure that different data sets are statistically comparable.
- One should note that different tick species and life stages are collected disproportionately by the various methods, so it may be necessary to use more than one method in order to develop a complete picture of an area's tick population.
- Tick drag is commonly used as a quick spot inspection.
- A tick drag can be made from a sheet of white material such as muslin or flannel that is normally 1 m by 1m wide which is attached to a wooden dowel and a piece of string.
- Pull the cloth over the vegetation in a given area and inspect and document any findings.
- When ticks are questing close to the surface of the ground or in dense vegetation, a tick flag will sometimes produce better results than a drag.
- A flag is made by attaching a piece of cloth to a stick or dowel so that it resembles a flag.
- The flag is then waved back and forth under, in and around vegetation or leaf litter, taking advantage of those areas where ticks are most likely to quest for their preferred host.
- To conduct a tick, one should wear white, 100% cotton clothing such as socks, pants or coveralls to highlight any ticks encountered.
- Pants should be bloused into socks or boots.
- If live ticks are required for disease testing, repellent should not be used, but openings in outerwear should be sealed with tape to prevent tick entry and attachment.
- Dry ice traps or the use of CO₂ can be used in any combination of the already covered techniques.
- To construct a CO₂ trap, simply place some dry ice in a vented, insulated container and set the container in the center of a sheet or board on the ground.
- If the trap will not be monitored, tape can be attached, sticky side out, on the perimeter to capture attracted ticks.
- Many variations on this theme have been developed, including traps designed to collect ticks over a 7-day period using a 12-kg block of dry ice, and traps with tubing to sample argasid ticks in burrows or tree cavities.
- Where dry ice is not available, gas cylinders or chemical generation may be used as a CO₂ source for traps.
- Host trapping is a great tool used to assess local tick populations, particularly if the host nest can be sampled and their contents extracted with Berlese-Tullgren funnels.
- Once the host is caught or captured, you would then inspect the host for ticks.

Slide 10.1– Disease Vector Control

Slide 10.2 – Disease Vector Control

- Overview

Slide 11.1 – Mosquito Control

- Mosquito Control Methods
- Temporary Control Procedures
- Adult Mosquito Control Procedures

Slide 11.2 - Mosquito Control Methods

- Directed against larvae and adult stages, using long term or temporary methods
- Long-term methods - Focus on controlling water where mosquito larvae breed
- If you remove the breeding areas, you can remove the mosquitos
- Mosquitoes need water to develop and without it the populations are unable to sustain themselves
- Temporary control methods - Larvicides and adulticides are the most important temporary mosquito control method.
- Using temporary and long-term methods will give you the best results because as you reduce the number of mosquitoes you are also eliminating their breeding areas.
- What to weigh/compare when considering long-term methods versus temporary methods:
 - Length of time required
 - Labor requirements
 - Equipment needed to perform the methods
 - Environmental considerations such as protected species, waterways and public health assessment

Long-term control procedures

- Ensure an environmental impact assessment has been completed.
- Coordinate with the Natural Resource Program manager, and your MAJCOM PMC to ensure controls will not have an adverse effect on the local environment.
- Locate the suspected mosquito breeding sites.
- Perform a thorough survey to determine if controls are needed.
- Determine which long-term method will be most effective for the situation:
- Ditching - Designed to remove standing water by digging a ditch so water flows away from the depression.
- Filling - Used to eliminate low lying areas by placing dirt, gravel, or any other suitable material into depressions.
- For problematic areas with low areas that collect water this is the best control method available to ensure no water remains standing and allow mosquitoes to breed.
- This is sometimes a very expensive and labor-intensive method but produces the best results.
- Due to stringent federal wetland laws, ensure you work with your engineering and/or environmental function before filling
- Pumping - Use pumps to drain water from areas at or below the water level of an adjacent body of water.

- Fish - Surface feeding fish can be used as supplementary control measures against mosquito larvae.
- The most useful fish are killifishes in saltwater and top minnows (Gambusia, Labistes and Panchax) in
- Improving natural drainage by removing aquatic vegetation and other blockages preventing water movement.
- Stream flushing- release collected water in waterways with dams or overflow a stream to wash away any stagnant water.
- Once the long-term control effort have been applied it is always best to perform a follow-up survey to determine effectiveness of the control.

Slide 11.3 - Temporary Control Procedures

- Larval Management - To manage temporarily mosquito breeding, treat water surfaces with insecticides or eliminate small water accumulations in temporary containers.
- Breeding areas include most types of groundwater accumulations as well as containers such as tin cans, cisterns, wells, reservoirs, fire barrels, roof gutters, tires, catch basins, and so forth.
- All such water-holding containers must be treated for effective management to be achieved.
- To treat the containers, use larvicide formulations such as solutions, emulsions, suspensions, dusts, and granules.
- Locate and survey suspected breeding sites
- Determine which larvicide formulation to apply.
- Liquid larvicide products containing *Bacillus thuringiensis israelensis*(Bti), are applied directly to water using backpack sprayers and truck- or aircraft-mounted sprayers.
- Tablet, pellet, granular, and briquette formulations of larvicides are also applied by mosquito controllers to breeding areas.
- Apply the larvicides according to the label requirements.
- Always perform a follow up survey one to three days later to check the activity levels of larvae and re-apply as needed according to the label.

Slide 11.4 – Adult Mosquito Control Procedures

- Coordinate with Public Health personnel to determine if controls are needed.
- Identify and prioritize sites to be controlled.
- Outdoor areas that are highly populated would be your top priority because it proposes the highest risk of people being affected by a high mosquito population.
- Determine which control method will be used.
- Mechanical and Physical Controls - Screening of windows, door and other openings prevents mosquitoes from entering occupied structures.
- Residual Sprays - Applied to all surfaces where mosquitoes are likely to rest such as service area or hospital and treat surfaces such as door and window screens, walls, corners, chest interiors, etc.
- Indoors - Space sprays are effective for managing mosquitoes indoors where immediate reduction is necessary.

- These sprays have little or no residual effect; therefore, you must reapply them whenever new mosquitoes enter the area.
- Where frequent reentry is a problem, or where disease-bearing species are present, apply residuals to all surfaces, where mosquitoes are likely to rest.
- Treat surfaces such as door and windows screens, walls, corners, and chest interiors.
- Outdoors - Ultra-Low Volume space treatments are used to manage adult mosquitos but cannot completely eradicate in the target area.
- Inspect ULV equipment to ensure proper working condition.
- Fill application tank with an approved adulticide.
- Drive to application site.
- Turn sprayer on and slowly drive through the area to be treated.
- Make enough passes to completely cover the entire area.
- Ensure a constant speed is maintained to properly disperse chemicals.
- Mosquitoes are generally the most important arthropods managed in contingency operations because of the number, types, and distribution of diseases they transmit.
- Actions must be taken by each individual to ensure they are protecting themselves from mosquitoes by using personal protective measures.

Individual Responsibility:

- Obtain and apply approved insect repellents
- DEET is the most effective and most widely used
- Oil of citronella has also proven effective
- In deployed environments adhere to the DOD insect repellent system
- Personnel should treat uniforms with permethrin
- Apply DEET to skin
- Properly wear the uniform
- Use Permethrin treated bed nets in areas with high mosquito populations

Slide 12.1 – Fly Control

- The first step in an effective fly control program is to ensure proper sanitation practices are being followed.
- Good sanitation removes food sources and primary breeding sites and should always be the primary method of dealing with any filth fly.
- Garbage Storage
- Proper storage - basic requirement for effective fly control
- Always keep lids on trash cans
- Trash should be in plastic bags to prevent garbage cans from getting filthy

Garbage Collection

- Should be picked up twice a week in residences
- Dumpsters should be emptied daily at food handling establishments
- Animal Waste - Needs to be picked up on a daily basis
- Vegetation Management - Eliminate over grown weeds that provide cover and harborage for flies
- Apply mechanical controls after determining proper sanitation alone is not solving the problem.

Screening

- Most widely used fly exclusion technique
- Size of screen should be about 16 mesh (16 strands/inch)
- Fly traps can be slightly modified to be used as a form of control.
- Electric Fans or Air Curtains - Mounted over doorways leading into food handling establishments to prevent flies from entering.
- Fly Strips have a sticky surface and pheromone which attracts and traps the fly.
- Biological controls can be applied but they are not usually an effective method for removing large population.
- Apply chemical controls if non-chemical controls are not effective or feasible.

Residual Sprays

- Apply to resting sites
- Treatments may need to be repeated often
- Not effective around garbage sites
- Always read the label before applying pesticides
- Have no residual effects
- Only kills flies present at the time of application and needs to be repeated often
- Examples include:
- Aerosols
- Automatic Aerosols - Disperse a small quantity of pesticide at regular time interval and primarily used in food handling establishments
- ULV Applications
- Fly Baits
- Space Sprays

Slide 13.1 – Mite Control

- Mites can be controlled through environmental methods, including sanitation, mechanical, construction and maintenance controls, as well as by chemical control methods.
- Mite management is based on a combination of avoidance, individual protective methods, sanitation, and chemical control.
- If avoidance is not possible, use personal repellents for individual protection, particularly where trousers are tucked into boots and at the waist.
- Chigger control depends on modifying the environment to permit sunlight and air to circulate freely, thus drying the usual damp habitat of the chigger.
- These procedures consist of:
- Keeping lawns and gardens closely cut and edged
- Eliminating shrubs, particularly blackberry and raspberry bushes, which furnish food and shelter for birds and rodents (hosts)
- Bird Mites can be controlled by:
- Modifying building so that birds cannot enter or nest.
- Trapping or poisoning birds to eliminate the source of blood for the mite.

Slide 14.1 – Bed Bug Control

Slide 14.2 – Bed Bug Control Methods

- An integrated approach to bed bug management is essential in eliminating a bed bug infestation.
- Insecticide resistance is very high in bed bug populations, therefore the use of a variety of pest control strategies and techniques, including the use of physical prevention and treatment methods, non-chemical and chemical control methods, and biological control methods are paramount to eliminating modern bed bug infestations.
- Vacuuming - vacuum all bugs, shed skins and eggs is very important.
- Ensure to focus on exposed areas and resting sites such as box spring edges or mattress seams.
- Vacuuming will immediately remove a sizeable portion of a bed bug population and will usually kill some them in the process.
- The used vacuum bag should be removed immediately afterward, sealed tightly inside a larger plastic bag, and that bag incinerated or placed in the next normal trash collection.
- Exclusion - due to bed bugs' weak, flexible, piercing-sucking mouthparts and weak feet and claws they cannot chew or claw through any type of fabric or barrier material.
- Sealing the openings between a harborage area and bed bugs' usual host access sites will restrict the bugs' movements and help temporarily reduce the intensity of their feeding.
- Storing clothes and other items in Ziploc® plastic bags or tightly-sealed containers can greatly reduce potential harborage sites.
- Commercially available plastic covers as well as fabric covers can completely enclose a mattress or box spring and prevent any bed bugs harboring in them from accessing hosts.

Slide 14.3 – Temperature Killing Techniques

- Bed bugs have been controlled by heating infested rooms or whole buildings to temperatures > 45°C (113°F), the thermal death point for the common bed bug.
- For heat treatment to be effective, it is critical that high temperature and low relative humidity be maintained at 120-degree F for a set minimum amount of time depending on the size of the facility.
- Heat Treatment Cautionary Notes: Heat treatment provides no residual effect, and bed bugs can re-occupy any site so treated immediately after temperatures return to suitable levels.
- Steam treatments have been used effectively by PMPs to quickly kill live bugs and their eggs in the seams of mattresses and other cloth items, as well as in cracks and crevices.
- Steam is less effective through fabrics and does not penetrate leather. This technique requires practice and care, and it is a slow process because it requires a speed of 3 cm/sec.
- Many times, the pressure of the steam will blow bed bugs into the carpet and surrounding areas, thus needing to apply a residual application.
- Exposure to low temperatures can kill bed bugs if they are kept cold enough long enough.

- Bed bugs can tolerate -15°C (5°F) for short periods and, if acclimated, they can survive at or below 0°C (32°F) continuously for several days.
- Cold treatments of rooms or whole buildings to control bed bugs have not been well studied, nor often employed, but freezing furniture or other items within containers or chambers below 0°F (-19°C) for at least four days may be a practical alternative for limited infestations or to augment other control measures.
- The use of CO₂ “snow” from pressurized cylinders, sprayed onto bed bugs and into their harborages, kills them by rapid freezing.
- As with steaming, care must be taken not to blow bed bugs and their eggs into other areas of the room.

Slide 14.4 – Bed Bug Pesticides

- Although pesticide resistance is common within bed bug populations, precise placement of a suitably-labeled, EPA-registered and formulated residual chemical insecticide is still an integral part of an effective integrated pest management program for bed bugs.
- Bed bug populations can be reduced/controlled by applying interior sprays or dusts to surfaces that the bed bugs contact and to cracks and crevices where they rest.
- Desiccant dusts and their physical mode of action and long residual activity, are superior to sprayable pyrethroid products for killing bed bugs.
- Diatomaceous earth, silica gel, or other properly-labeled dust formulations are used to treat certain sites, like cracks and crevices.
- Residual sprays carefully placed where bedbugs frequent have shown satisfying results.
- Liquid applications should never be placed around any electrical outlets.
- Insecticides currently labeled for application by ULV, aerosols and foggers have little or no residual effects on bed bugs.
- When used according to their own product label directions, most of these applications will seldom penetrate into typical, cryptic bed bug harborages.
- If directly injected into such harborages, these products may stimulate some of the bed bugs to become active and move out into the open, allowing them to be seen by inspector The follow up inspection is just as important as the initial survey and actual treatment.
- The follow up inspection is just as important as the initial survey and actual treatment.
- At least one follow-up inspection of infested sites should be conducted at a suitable interval, 10-21 days after each control effort or treatment, to detect any of the typical signs of continued infestation, such as live bugs, or any new cast skins, fecal spots or unhatched eggs.
- NOTE: Timing of the follow-up should be based on the approximate temperature of the premises to best detect recently hatched nymphs and bed bugs that may have survived through the treatment.

Slide 15.1 – Lice Control

- Lice infestations can cause distress and disrupt normal operations, requiring pest management to perform control procedures to appease the people in the building.
- Direct the requester to the medical treatment facility.
- Pest management personnel are not trained or authorized to diagnose or treat lice on personnel.
- Treatment must be accomplished by medical personnel.
- Apply residual sprays in infested areas such as:
 - Restrooms
 - Public areas
 - Infected person's room
- Sanitation and laundering all linens and clothing is extremely important in helping kill of any living lice off the host

Slide 16.1 – Flea Control

- The most common controls involve insecticides.
- They are divided into two categories:
 - Control of fleas on pets (primarily on cats and dogs)
 - Control of fleas on premises
- It is the pet owner's responsibility to treat their pet.
- Common control procedures must be coordinated with the pet owner.
- Inspect area to determine location and extent of the problem.
- Ensure the pet owner accomplishes the following prior to your arrival.
- Thoroughly vacuum - pay special attention to resting areas.
- Launder or destroy bedding.
- Have pets treated while you are treating the premises.
- Treat premises with a residual insecticide.
- Pay special attention to carpets, furniture, pet resting areas, and other likely areas.
- Use a light fan spray to gently wet all surfaces.
- Treat lawns and yards with a wettable powder (emulsions and solutions may burn lawns and shrubs on hot days).

Slide 17.1 – Tick Control

- Tick control is very similar to techniques for managing mites.
- Personal Protection procedures:
 - Keep clothing buttoned and trouser legs tucked into socks to prevent ticks from entering your clothing.
 - Avoid sitting on the ground or on logs in brushy/shrubby areas.
 - Frequently inspect clothing and body using the buddy system
 - The use of repellents offer some degree of protection
- Dogs are most commonly infested with one of the following:
 - Brown Dog Tick
 - American Lone Star Tick
 - American Dog Tick

- If left untreated domestic animals can be seriously hurt or even killed due to the loss of blood/anemia
- Pet owners are responsible for treating their pet.
- Locate tick hot spots
- Apply a contact or residual insecticide to baseboards, floor and wall crevices, window frames, and other noted harborage spots
- Ensure pet is treated before or during treatment of the facility
- Mow overgrown vegetation to prevent ticks from easily entering
- Apply residual insecticides (liquid, dust, or granule) on grass areas and under shrubbery and trees
- Treat along roads, trails, other recreational areas
- Pay special attention to where dogs frequent
- Removal of pets may be the only method in severe infestations after all other controls have failed

Slide 18.1 – Course Completion

Congratulations, you have completed the disease vectors lesson. Please click complete course to receive credit.

3E453 – Pest Management Journeyman

Module 4, Unit 2, Lesson 1 (10.5.1, 10.5.2, 10.5.3) Stored Product and Fabric Pests

Slide 1.1 – Introductory Slide

Slide 1.2 – Lesson Title Slide

3E4X3 Career Development Course

10.5.1, 10.5.2, 10.5.3 STORED PRODUCT AND FABRIC PESTS

Slide 1.3 – Instructions

Welcome to the Stored Product and Fabric Pests Lesson.

Upon completion of this lesson, you must be able to identify basic facts and principles relating to Stored Product and Fabric Pests with at least 75% accuracy.

Slide 1.4 – Overview

In this section, we will cover the following topics:

- Identify, Survey and Control Measures
- Stored Product and Fabric Pest Survey
- Control Measures For Stored Product and Fabric Pests
- Fabric Pest Management Methods

Slide 2.1 – Identify, Survey and Control Measures Intro

Slide 2.2 – Menu

- Stored Product and Fabric Pests
 - Stored Product Pest
 - Fabric Pest
 - Moths
 - Weevils
 - Beetles
 - Stored Food Pest

Slide 2.3 – Stored Product Pest

- Stored product pests feed on and contaminate food sources, and ruin clothing and materials.

- Often, you may hear these pests being called “economic pests,” because they have a direct impact on funding when we must replace food and materials destroyed or contaminated by infestation.
- The Defense Logistics Agency (DLA) is responsible for procuring and warehousing products.
- DLA manages a major portion of the Department of Defense (DoD) worldwide pest management program, both in its depots and I military service depots.

Slide 2.4 – Stored Food Pest

- Overview
 - The losses from stored- food products pests cost the military millions of dollars each year
 - These losses occur not only from the direct cost of destroyed products, but also from replacement and transportation costs for shipping new supplies—often to foreign countries
 - These pests have a significant impact on stored-food supplies of contingency operations
- Logistics
 - Goods in transit are common sources of stored-product pests' infestations
 - The more environments stored foods are exposed to as they travel from the mill or factory to the consumer, the greater the risk they will become infested.
 - Because many of our military operations occur overseas, the risk of stored-products pest infestation during transit is greater for the military community than it is for the civilian community.
- Economics
 - Military operations are often in hostile or conflict-ravaged areas. In these settings, the locally purchased stored products are often not available or reliable.
 - To ensure our fighting men and women have adequate food supplies they need to sustain themselves, stored products must be transported over great distances from reliable sources.
 - An infested pound of flour discarded halfway around the world is much more expensive than a pound of infested flour discarded from a local supermarket.
 - For these reasons, it is critical for the military services to maintain an aggressive, effective, and consistent stored-products pest management program.
- Identification
 - We classify stored-product pests by the material they infest which are:
 - Food
 - Fabric
 - Wood
- Types
 - Moths - Moth larva are the most damaging stages; adult stage makes them easier to identify.

- Beetles - Unlike the moth species, both the larvae and adult life stages of beetles readily damage stored products.
- Weevils - similar in appearance to beetles; however, their head is elongated and usually curved downward to form a snout that has jaws at the tip antennae are usually geniculate (bent abruptly at an angle), and the covering of their body is tough and hard

Slide 2.5 – Moths

- They infest whole grains (e.g., wheat, barley, rye, corn, oats, and rice) and various seeds.
- Infestations in storage areas are most serious where warehouse management neglects good housekeeping and grains are openly scattered.
- These moths are common throughout the world and are particularly damaging in tropical and subtropical areas.

Slide 2.6 – Angoumois Grain Moths

- The adult Angoumois grain moths (*Sitotroga cerealella*) are small, buff or yellowish-brown colored insects that have a 1-inch wingspan, fringed hind wings, and a point at the tip.
- Life Cycle
 - Go through complete metamorphosis
 - The females lay eggs on the surface of grain kernels.
 - As the eggs hatch, the larvae enter the kernels, where they feed and develop.
 - When the larvae are fully grown, they cut a circular opening through the seed coat, leaving a flap to cover the hole
 - Adult moths then emerge after a 10- to 14-day pupation period
 - In warm areas, the Angoumois grain moth life cycle may take 5 to 7 weeks, and in heated warehouses there may be 10 to 12 generations per year.
 - In less temperate areas, the larvae survive the winter in the grain kernels, and the life cycle may last up to 6 months.

Slide 2.7 – Mediterranean Flour Moth

- Adult Mediterranean flour moths (*Anagasta kuehniella*) have a wingspan that is a little more than 1 inch.
- Forewings are pale gray with transverse wavy black markings, which often have been rubbed off older specimens.
- Hind wings are a dirty white color. 1/4 to 1/2 of an inch long with a 1 inch wing span.
- The forewings are pale gray with wavy transverse black markings.
- The hind wings are a dirty-white color.
- Life Cycle
 - Go through complete metamorphosis
 - Females place eggs on the food surface, where they hatch in a few days. Like the Indian meal moth larvae, the Mediterranean flour moth larvae spin silken threads wherever they go.
 - These threads web and mat the particles of material together where the larvae feed.

- When fully grown, the ½-inch-long larvae may stay where they have been feeding, or they may migrate to other parts of the warehouse.
- The larvae usually spin silken cocoons; however, they may pupate in cracks and crevices without cocoons.
- In warm buildings, the Mediterranean flour moths may complete their life cycle in 4 to 8 weeks.
- Importance
 - Infest flour and meal
 - While they prefer cereal products, they also consume many other foods, including whole grain, bran, seeds, biscuits, and dried fruit

Slide 2.8 – Indian Meal Moth

- Adult Mediterranean flour moths (*Anagasta kuehniella*) have a wingspan that is a little more than 1 inch.
- Forewings are pale gray with transverse wavy black markings, which often have been rubbed off older specimens.
- Hind wings are a dirty white color. 1/4 to 1/2 of an inch long with a 1 inch wing span.
- The forewings are pale gray with wavy transverse black markings.
- The hind wings are a dirty-white color.
- Life Cycle
 - Go through complete metamorphosis
 - Females place eggs on the surface of the food products, where they hatch in a few days
 - Larvae leave silken threads wherever they crawl (through or over food), forming a loose webbing that is easy to identify in heavy infestations.
 - Infestations result in a mat-like mass of moist decomposing food and webbing.
 - When they are fully grown, the ½ inch-long larvae pupate in silken cocoons.
 - In warm weather, it takes 4 to 8 weeks to complete this life cycle.
 - Indian meal moth larvae feed in or near tunnel-like cases they have webbed together of grass and silk
- Importance
 - Infest broken grain and cereal products, they prefer coarse grades of flour and milled products over the more highly refined grades.
 - Nevertheless, they infest a wide variety of dry food products, including dried fruit, nuts, graham crackers, and powdered milk.

Slide 2.9 – Warehouse Beetle

- Adult warehouse beetles (*Trogoderma variabile*) range in length from 1/10 to 1/6 inch.
- They are oval shaped and normally black with variable patterns of dark, reddish-brown blotches.
- Life Cycle
 - Warehouse beetles lay their eggs in or on food items and hatch in about 7 days.
 - The larvae are yellowish brown and covered with the long-barbed setae, small bristle like hair.
 - They normally feed for about 30 to 35 days before pupating.

- If conditions warrant, the last larval instar can go into diapause (delayed development) for several months.
- Importance
 - Warehouse beetles infest a wide range of raw and processed food products.
 - Adults can penetrate packaging film—even meals, ready to eat (MRE).
 - These beetles are the most common of all *Trogoderma* species found in processed foods, such as beans, flour, cornmeal, cocoa, breakfast cereals, and cookies.
- Medical Importance
 - Warehouse beetles possibly have the most adverse impact on food because of the barbed setae that cover the larvae bodies.
 - Each larva has thousands of setae that readily break off and contaminate the food it infests.
 - When people eat the contaminated food, these setae enter the intestinal lining and cause dysentery and diarrhea.
 - Therefore, military food sanitation standards require that food products infested by *Trogoderma variabile* be destroyed.
 - Reference MIL–STD–904B, Department of Defense Standard Practice, Detection, Identification, and Prevention of Pest Infestation of Subsistence.

Slide 2.10 – Red and Confused Flour Beetle

- The adult red and confused flour beetles (*Tribolium castaneum* and *Tribolium confusum*) are a shiny reddish brown.
- They are 1/7-inch-long flattened ovals that have tiny punctures densely covering the head and upper part of the thorax.
- These tiny punctures are less dense between the ridges of the lengthwise ridged wing covers.
- There are only two characteristics that distinguish between the two species:
- The red flour beetle can fly, but the confused flour beetle cannot.
- The last three segments of the red flour beetle's antennae enlarge abruptly to give them a club appearance, while the confused flour beetle's antennae enlarge gradually.
- Life Cycle
 - The life cycle takes about 6 weeks during the summer
 - Eggs are deposited loosely in flour and other food, and they are covered with a sticky solution, so they become coated with flour and bran
 - They hatch in 5 to 12 days
 - Full-grown larvae pupate when they are about 3/16 inch long
 - Pupae are naked, having no cocoon or other covering
- Importance
 - These flour beetles are two of several related insects that are commonly called “bran bugs”.
 - They are among the most common pests found in cereal products (e.g., flour and meal), and are two of the worst insect pests for prepared cereal products.

- They are general feeders; therefore, they also infest peas, beans, nutmeats, dried fruits, and spices.
- Red and confused flour beetles are found throughout the world wherever grains and grain products are stored

Slide 2.11 – Saw-toothed Grain Beetle

- Slim, 1/8 of an inch long
- Dark brown with flattened body and well developed wings (but it does not fly)
- The pronotum has two deep longitudinal grooves and six sharply pointed projections on each side of the thorax
- Life Cycle
 - The female beetles drop eggs loosely on foodstuffs, or deposit them in crevices in grain kernels
 - After 3 to 5 days, the eggs hatch and the larvae actively crawl as they feed on available food; when full grown, they are about 1/8 inch long
 - To pupate, they form a cocoon-like structure by cementing together fragments of grain and other foods
 - In the summer the life cycle is 3 to 4 weeks long
 - Adults normally live for 6 to 10 months

Slide 2.12 – Rice Weevils

- Adult rice weevils (*Sitophilus oryzae*) are small snout beetles that are rarely over 1/8 inch long
- Their slender snout has two strong mandibles (or jaws) at the tip
- Adult weevils are reddish-brown to black, usually with four light reddish to yellowish spots on the back
- Their thorax is densely pitted with round punctures, and they have well-developed wings under the wing covers
- Life Cycle
 - Rice weevils are widely distributed, but they prefer a temperate or subtropical climate
 - Can complete their life cycle in 1 month
 - Adult females cut a small hole in whole grains, deposit an egg, and seal it in place with a gelatinous material
 - Each larva stays in the grain; the pupa remains there too.
 - The adult weevils leave the grain after cutting an opening; This process is modified slightly in products such as macaroni.
- Importance
 - These weevils mainly infest whole grains, and are the most destructive of all stored-grain pests
 - At times, they infest solid farina products, such as macaroni and caked or compressed flour

Slide 2.13 – Granary Weevils

- The adult granary weevils (*Sitophilus granarius*) resemble the rice weevils in the types of food they attack, in their size and color, and in their life cycle.

- These two types of weevils are often found together, but there are three differences between them:
 - Granary weevils are a more serious pest in northern climates.
 - Granary weevils cannot fly like the rice weevils because they have no wings under their wing covers, instead they move from one location to another with infested grains.
 - The thorax of the granary weevils is marked with longitudinal punctures, rather than with the round punctures found on the rice weevils.
 - Major pest of the North

Slide 2.14 – Fabric Pest

- WEBBING CLOTHES MOTH
 - About ½ inch long
 - Wings golden color
 - Hairs on top of head reddish-gold color
 - Usually fixed silk tubes sometimes bearing frass often the same color as cloth
 - Nap of wool eaten away in spots if lightly damaged, holes completely through fabric if infestation extensive
 - Larvae may be present in tubes
 - If fur, hairs are cut at base causing loose fur and exposing hide with webbing
 - Fecal pellets are bun-shaped
- CASEMAKING CLOTHES MOTH
 - Darker brown, ranging in size from ½” to 5/8” long
 - Three dark spots on forewings, but are easily rubbed off and are often indistinct
 - Larva spins a cigar shaped case around itself and carries it as it feeds
 - Cigar-shaped cases 1/16 to 3/8 inch usually attached to the fabric at one end. Cases are white or bearing slight colors of the infested fabric.
 - Cases appear to move about if larvae are inside and are stationary if they contain pupae or if empty.
 - If cases are absent, damage is recognized as surface feeding in irregular furrows or when damage is severe, by holes through fabric.
 - Webbing is absent
- BLACK CARPET BEETLE
 - Adults are oval and elongate, and dark brown to black in color
 - 1/8” to 3/16” long
 - Yellowish legs
 - Attack wool fabrics and furs, and can also be found in warehouses and grain mills
 - Cuts carpet fibers at the base and there is no presence of holes
 - Common Carpet Beetle
 - About 3/16” long
 - Pronotum and wing covers have black scales with white wavy design
 - Wing seam, margins, and part of pronotum with marked red scales
 - Leaves the tips of carpet fibers damaged and there is a presence of holes

Slide 3.1 – Stored Product and Fabric Pests Survey Intro

Slide 3.2 – Stored Product and Fabric Pests Survey

- Stored Product Pest
- Visual Inspection
- Signs of Activity
- Traps
- Fabric Pest

Slide 3.3 – Visual Inspection

- Initial
 - A visual inspection is necessary as soon as supplies enter the warehouse or, preferably, before they are unloaded.
 - If goods are heavily infested, the lot must be rejected. However, if inspection shows only a light surface infestation, it may be possible to fumigate and salvage most of the product.
 - With food, the salvage potential depends on the pest involved and when the product was found to be infested.
 - Local US Army Veterinary Corps and USAF Public Health Officers must make all decisions concerning salvage and fumigation following the guidance in MIL–STD–904B, Department of Defense Standard Practice, Detection, Identification, and Prevention of Pest Infestation of Subsistence.
 - For fabric pests, infestation is usually unnoticed until someone closely notices the damage associated with these pests.
 - A flashlight, small knife, or spatula will aid in inspections
- Frequency
 - Qualified people must inspect supplies in storage at least monthly.
 - For direct product inspections, inspection equipment includes a flashlight, magnifying glass, hand sifter, and bag ties.
 - Normally, inspecting 5 percent of the lot will indicate the condition of the entire lot; spot inspections must not exceed 10 percent of the lot.
- Early Detection
 - Infestations in sacked foods are usually advanced, and a visual inspection often detects both larvae and adult insects.
 - But to detect early infestations, or infestation of products in multi-wall bags, you will have to open the bags and sift samples of the contents.
 - Randomly select, empty, and sift containers of spices, pepper, dried milk, and other finely divided subsistence items.
 - Look for evidence of beetles, moths, silverfish, and other destructive pests.
 - Also, carefully inspect folds and seams of the bags themselves.

Slide 3.4 – Traps

- In addition to these inspection measures, there are many types of pheromone traps
- Before using these traps, however, obtain all available information about local stored-product pests and the availability of appropriate traps
- You may use traps as an indirect inspection tool outside a warehouse
- This reduces the need to open commodities during direct product inspections

- Further, it enables pest management personnel to track the presence of pests that have previously attacked commodities.
- Like pesticides, follow all label instructions for using these traps
- To learn more about trapping stored-product pests, refer to AFPMB TG No. 27, Stored-Product Pest Monitoring Methods.
- Contact your MAJCOM Pest Management Consultant if there are any concerns about their use

Slide 3.5 – Fabric Pest Surveys

- Many items made wholly or partially of animal products such as hides, hair, fur, bristles, wool, mohair, feathers, and down are subject to attack by more than 30 destructive insects.
- The most destructive of these are the black carpet beetles, common carpet beetles, webbing clothes moths, and the case-making clothes moths.
- Signs of damage may only become visible after an infestation has long been established.
- Clothes moth and carpet beetle larvae feed deep in the carpet pile in dark and undisturbed areas, meaning infestations may go undetected for years, particularly if the areas are not regularly cleaned.

Slide 3.6 – Signs of Activity

- Live or dead adult insects, such as carpet beetles or fabric moths are often found gathered around window openings.
- To confirm their presence, move heavy items of furniture to expose carpet underneath. Look for moths that may scurry or fly from behind or underneath furniture.
- Feces and shed skin can be another sign of an infestation.
- Carpet beetle larvae produce fecal pellets about the size of a salt grain and shed brown shell-like cast skins.
- These will be concentrated in the source area of infestation.
- Part the carpet pile to expose the backing in several areas under, around, and in corners by furniture, and examine for the presence of insect droppings.
- Examine the surface of the carpet in the same areas for loose or eaten pile and insect debris such as silk threads, cocoons, tubes, cases, and cast skins.
- Look for signs of larvae that may be present.
- Fabric pest larvae prefer to hide in quiet, dark, undisturbed locations such as under large items of furniture (that are not often moved) or in wardrobes or closets.
- Carpet beetle larvae have alternate light and brown striped bodies and are covered with dense tufts of hair.

Slide 3.7 – Stored Product Pest

- Except for products stored in cans, virtually all items of subsistence are susceptible to damage by insects, rodents, or other pests.
- Stored-product insects may attack woolens, mixed woolens, furs, feathers, felt, natural fibers, and untreated hardwoods.
-

- This makes the pest manager's work critical, particularly when the climate and other environmental conditions are conducive to incubation and migration
- Proper preventive measures are essential to manage stored-product pests effectively including:
 - purchasing insect-free products
 - effective surveillance inspections
 - minimizing storage periods for individual lots
 - preventive maintenance in storage depots
 - using insect-proof wrapping and containers
 - storage at low temperatures
 - using fumigants and insecticide treatments
- Our first topic explores the various inspection activities for stored-product pests.
- For further explanation and resources in stored product pest, reference AFPMB TG 27, Stored-Product Pest Monitoring Methods.

Slide 4.1 – Control Measures, Stored Product and Fabric Pests Survey Intro

Slide 4.2 – Control Measures, Stored Product and Fabric Pests

- Preventative Measures
 - Proper preventive measures are essential to effectively manage stored-product insects and are considered the most important control method.
 - These measures include:
 - Purchasing insect-free products
 - All products for military use must be inspected when they are purchased
 - These products must be inspected again upon delivery to ensure no infested items are placed in military depots to infest clean stocks
 - Also, trained observers must periodically inspect food-processing plants that have military contracts
- Surveillance Inspection
 - Inspections are the backbone of the military pest management program
 - They are the primary responsibility of the US Army Veterinary Corps and US Air Force Public Health Officers
 - Inspections are also the responsibility of storage and pest management personnel
 - These sections must routinely look for any abnormal situations that may indicate pest infestations
 - Joint monthly inspections by representatives of both sections are often very productive and highly encouraged
- Storage Period
 - The storage period for military supplies must be as short as possible—consistent with economic and normal depot operational requirements.
 - This is important, because under the right conditions (from the insect's point of view) early weevil, moth, beetle, and other pest infestations develop into large and destructive populations within a few months.
- Storage Depot
 - One of the easiest and most basic preventive measures available is proper lighting

- Example: mercury vapor lamps give off a light that attracts flying insects
- Avoid using these around food storage buildings and nearby parking lots' Instead, use high-pressure sodium lamps whenever possible because they do not readily attract insects.
- In either case, when placing lights around storage facilities use indirect lighting
- Do not place lights over entrances and doors, particularly if warehouse doors are often open at night
- Storage Periods
 - Vegetation around warehouses must not attract flying insects and it must be maintained at least 2 to 3 feet away from warehouses.
 - This provides a barrier strip between the vegetation and outside wall of a storage building where residual pesticides can be applied to control crawling pests, such as ants.

Slide 4.3 – Control Measures: Sanitation

- Sanitation
 - Basic rules of cleanliness and warehouse sanitation must be observed in all storage areas.
 - All broken or torn containers must be promptly removed to a salvage area, and spilled foodstuffs discarded.
 - Accumulations of bits of subsistence items, woolen lint, and similar materials in cracks will support the growth of stored-product pests.
 - Animal foods must be isolated from cereal products and dried fruits and, if possible, stored in a separate building.
 - Precautions against insects in meat storage areas include proper disposal of trimmings and frequent floor scrubbing.
 - Interiors of freight cars, trucks, and other conveyances must be insect-free before they are loaded. If a conveyance cannot be made insect-free or easily fumigated, it must be rejected.

Slide 4.4 – Control Measures: Using Insect-proof wrapping and containers

- Using Insect-proof Wrapping and Containers
 - Properly sealed containers provide protection for subsistence items and other packaged goods.
 - Metal and glass containers give food total protection against outside infestations.
 - Flour, beans, peas, and rice are greatly protected by shipment in multi-wall paper bags with tight end closures.
 - When an inner liner is treated with an approved insecticide, the product is protected against insect infestation for up to 12 months
 - This protection begins at the time the bag is filled

Slide 4.5 – Control Measures: Storage at Low Temps

- Storage at Low Temps.
 - Take full advantage of climatic conditions to expose stored items to low temperatures.

- This is applicable only when such exposure will not injure the goods.
- Storage at 50 °F and below will arrest development and feeding of most storage pests.
- Most stored-product pests will not produce eggs even at slightly higher temperatures.
- Essentially, all development stops at 40 °F.
- At this temperature, insects die or must go into diapause.
- Nonetheless, low temperatures are not a cure for all stored-product pests.
- For some stored-product food pests, the product must remain at –5 °F for a week to kill all stages—including the eggs.
- In warm climates and during summer months, goods must be stored under dry conditions whenever possible.
- Insects in stored products tend to develop at a faster rate when these products have a high moisture content.

Slide 4.6 – Control Measures: Using of Fumigants and Insecticide Treatments

- Residual Sprays
 - Always treat shipping containers before goods are loaded and try to conduct residual treatments of warehouses before products go into storage.
- Fumigants
 - Fumigating commodities in storage is a fast, direct, and effective way to eliminate all stages of living insects in stored products.
 - Fumigation with phosphine (hydrogen phosphide gas) is widely used since it is easy, economical, relatively safe, and leaves no residue in foods. Phosphine may be used for stack fumigation in a warehouse without closing the facility, and it is the only type of fumigant approved for use in moving rail cars.
 - Shippers are normally required to use rail car fumigation during the summer months for shipments from a manufacturer to the military and between military installations.
 - Therefore, all military installations that receive rail car shipments of subsistence need a trained two-person fumigation team equipped to conduct and clear such rail car fumigations, as well as normal stack fumigations.

Slide 5.1 – Fabric Pest Management Methods Intro

Slide 5.2 – Control Measures Fabric Pests Management Methods

- Cleaning and Preventative Practices
 - Prevention includes summer/winter storage of clothing in tightly sealed containers with moth balls or crystals.
 - Studies have shown cedar is not a repellent and does not discourage larvae from feeding.
 - Management Techniques:
 - If a fabric pest is present, there are multiple avenues of control that can be implemented to help in controlling the given pest.
 - We can break down the control methods into two categories: Chemical and Non-chemical controls.

- Non-Chemical Controls
 - Vacuuming:
 - In addition to killing the fabric pests themselves, vacuuming will remove hair, dead insects and other debris these insects feed on.
 - Vacuuming carpets, areas along and under baseboards, behind and under furniture, under furniture cushions, inside dressers and chests will help minimize damage from fabric pests.
 - Oriental rugs should be vacuumed on both sides
 - Laundering or dry cleaning:
 - Before storing clothing, it should be laundered or dry cleaned.
 - Using extreme heat (120 to 150 °F), dry cleaning kills all stages of fabric pests.
 - Pheromone Traps:
 - Effective pheromone traps are available for webbing clothes moth, case making clothes moth, varied carpet beetle and black carpet beetles.
 - Cold Storage:
 - Dry cleaners may offer cold storage for furs and other valuable fabrics
 - Professional mothproofing may be helpful in protecting valuable oriental rugs
- Chemical Controls
 - Naphthalene and paradichlorobenzene (PDB) are sold as moth balls, crystals, cakes, or flakes.
 - These products are mild fumigants which means they produce a gas at room temperature which may be somewhat toxic to these pests.
 - Of the two active ingredients, PDB is more toxic to insects.
 - At room temperature and in high concentrations for several weeks, the heavy gas produced kills all stages of carpet beetles and clothes moths.
 - Crystal formulations release gas more quickly than cakes or balls.
 - One disadvantage of paradichlorobenzene is it can damage plastics, including polystyrene and Styrofoam as well as the plastic in many sweater boxes.
 - Plastic buttons may also be damaged.
 - Damage to plastic may be from direct contact or vapors.
 - Naphthalene controls clothes moths when high concentrations of the gas are produced, but carpet beetles are poorly controlled.
 - It is best used by scattering balls or flakes in clothing
 -
 - Under moist conditions, it may discolor fabrics so it should be placed in a manner so that it does not contact the fabric.
 - Placing naphthalene in or on papers may help.
 - Naphthalene does not damage plastics, but will corrode metal.
 - There are several common household insecticide sprays available for fabric pest control.
 - All should be equally effective if used properly.

- This means applying the sprays to cracks and crevices in closets and chests where the pests may be hiding.
- Sprays should only be used if an infestation exists.
- Sprays will not be effective as a preventative measure and should never be applied directly to fabrics.

Slide 6.1 – Course Completion

Congratulations, you have completed the identify, survey & control measures lesson. Please click complete lesson to receive credit.

3E453 – Pest Management Journeyman

Module 4, Unit 3, Lesson 1 (12.1.1) Aircraft Disinsection Principles

Slide 1.1 – Introductory Slide

Slide 1.2 – Lesson Title Slide

3E4X3 Career Development Course

Slide 1.3 – Instructions

- Welcome to the lesson Aircraft Disinsection Principles
- Without reference, identify the relationship of basic facts and state general principles about aircraft disinsection principles with at least 75% accuracy.

In this section, we will cover the following topics:

- Introduction
- Responsibilities as Pest Manager
- Procedures

Slide 2.1 – Aircraft Disinsection

Slide 2.2 – Aircraft Disinsection Introduction

- Definition
- Purpose

Slide 2.3 – Aircraft Disinsection Definition

- Disinsection of aircraft is a quarantine procedure to prevent the transfer of live disease vectors from infested areas to non-infested areas. In this lesson, you will understand it's purpose, your responsibilities as a pest manager, and disinsection procedures.

Slide 2.4 – Aircraft Disinsection Purpose

- Certain countries require inbound aircraft to be disinfected in order to reduce the accidental importation of potential disease vectors (e.g., mosquitoes), invasive agricultural pests, and other invasive arthropods.
- AFPMB Technical Guide 4, Disinsection of Military Aircraft outlines aircraft disinsection procedures for all DoD-owned or operated aircraft. The technical guide only applies to the disinsection procedures and does not address country-specific entry requirements such as immigration, customs, or quarantine requirements.
- Country specific entry requirements can be found on the DoD Foreign Clearance Guide at <https://www.fcg.pentagon.mil>.
- The United States does not require aircraft arriving in the United States to be disinfected. No product for in-flight disinsection of passenger or crew cabins is registered by the U.S. EPA.

Slide 3.1 – Responsibilities As A Pest Manager Introduction

Slide 3.2 – Responsibilities As a Pest Manager

- The original CoD must be retained onboard the aircraft to ensure documentation of compliance with DoD certification requirements. A copy of the CoD, either a photocopy, scan, or second original, must be retained in the aircraft record per aircraft maintenance standard operating procedures.
- It is the responsibility of the aircraft commander to have the aircraft treated prior to pre-embarkation. Treatment is verified on DD Form 3044, Pre-Embarkation Certificate of Disinsection. Disinsection treatments will be conducted as outlined in section 3 of Technical Guide No. 4.
- A Certificate of Disinsection (CoD) DD Form 3044 (Appendix A) will be filled out and signed by the DoD disinsection-trained applicator upon completion of an aircraft disinsection procedure. This form is accessible at <http://www.esd.whs.mil/portals/54/documents/dd/forms/dd/dd3044.pdf>.
- DoD-certified applicators are the primary personnel who will carry out the disinsection process. If certified applicators are unavailable, non-DoD-certified applicators such as aircrew and aircraft maintenance personnel may carry out disinsection procedure.
- The DoD will ensure that aircrew, certified pest management personnel, and disinsection trained personnel are cognizant of and understand the requirements of the Foreign Clearance Guide and any host nation standards for aircraft disinsection.
- Mandatory reporting of all applications of disinsection products per Department of Defense Instruction (DoDI) 4150.07, DoD Pest Management Program.

Slide 4.1 – Procedures Intro

Slide 4.2 – Procedures

- Consult the DoD Foreign Clearance Guide for appropriate product and amount of needed pesticide per aircraft specification.
- Follow label and ensure appropriate PPE is worn.
- Spraying must be completed using Callington Aircraft Insecticide (2% permethrin).
- The treatment is to be carried out at the last airbase, airport, or airfield before departure to the destination.
- Treatment must take place after cargo has been loaded and prior to the commencement of passengers and crew boarding, in the absence of crew and passengers.
- Air conditioning system including any pre-conditioned air from a ground support unit must be turned off. Recirculation fans may be left on if essential to the operation of the aircraft, but set to the lowest rate.
- The aircraft must be fully loaded and service doors closed; one main entry door per level may remain open to facilitate operational requirements.
- Application will be completed and aircraft ventilated per the product label prior to allowing passengers and crew to board and catering being completed.
- Overhead storage bins and sidewall lockers must be open during the spraying.
- Direct spraying towards the open overhead storage bins and ceiling while walking along the aisle at a rate of not more than one step or one row of seats per second.

- Spray all galleys, including those on lower levels and the lift access.
- Spray all toilets and coat lockers for two seconds each.
- Spray all crew rest areas and the flight deck for three seconds each, directing spray away from aircraft equipment and electronic systems.
- All cans from the flight deck, cabin, and hold areas used for aircraft disinsection will be consolidated and remain on the aircraft with the CoD as evidence of disinsection.
- Upon completion of aircraft disinsection, the DoD-trained applicator will complete all sections of the CoD IAW paragraph 3.7. Applicators will fill out and submit DD 1532-1 per DoDI 4150.07.
- Inability to meet the procedures prescribed in Technical Guide No.4 and the country-specific information in the Foreign Clearance Guide must be reported to the Air Attaché for the destination country as soon as possible.

Slide 5.1 – Course Completion

Congratulations, you have completed the aircraft disinsection principles lesson. Please click complete course to receive credit.

3E453 – Pest Management Journeyman

Module 4, Unit 3, Lesson 2 (12.2.1) Retrograde Wash-down

Slide 1.1 – Introductory Slide

Slide 1.2 – Lesson Title Slide

3E4X3 Career Development Course

Slide 1.3 – Instructions

- Welcome to the Retrograde Wash-Down lesson
- Upon completion of this lesson, you must be able to successfully identify the relationship of basic facts and state general principles relating to Retrograde Wash-down with at least 75% accuracy.

In this section, we will cover the following topics:

- Impact of Invasive Species
- Pest of Military Importance
- Wash-down Procedures

Slide 2.1 – Impact of Invasive Species Intro

Slide 2.2 – Impact of Invasive Species

- An invasive species is a non-native species that, when introduced, causes or is likely to cause economic or environmental harm or harm to human health.
- Invasive species often reduce both economic productivity and the ecological integrity of U.S. agricultural and natural resources thereby having significant impact on the food supply.
- Invasive species impact military operations by causing an increase in restrictions on land use associated with the decline of native populations, endangered species, shifts in predator/prey dynamics, shifts in species niches, changes in habitat, and reductions in ecosystem complexity.

Slide 3.1 – Pest of Military Importance Intro

Slide 3.2 – Pest of Military Importance

- Importation of invasive species in or on military vehicles, vessels, and equipment present in areas frequented by the DOD is a primary concern of the USDA.
- DOD policy mandates that all organizations and personnel involved in the movement of DOD-sponsored cargo, personal property and accompanied baggage will take the steps necessary to prevent the spread of exotic pests, and plant and animal diseases from one location to another.

- Plant debris, garbage, food, soil, and even fresh water from foreign countries can harbor a multitude of organisms that are of quarantine importance. All soil from outside CONUS is prohibited.
- Examples of invasive vertebrates: Nutria, House Sparrows, European Starlings, Burmese Pythons, Roof Rats, Norway Rats and House Mouse
- Examples of invasive invertebrates: Zebra Mussels, imported Fire Ants, Africanized Honey Bees, Asian Tiger Mosquito
- Examples of invasive Plants: Kudzu, Cheat Grass, Garlic Mustard, Chinese Tallow, Hydrilla, Brazilian Pepper Trees

Slide 4.1 – Washdown Procedures Intro

Slide 4.2 – Washdown Procedures

- AFPMB TG 31, Guide for Agricultural Preparation of Military Gear and Equipment for Redeployment lists specific requirements for wash-down procedures

LOCATION OF WASH-DOWN

- The location must have hardstand where soil will not transfer to tires and a large fresh water supply. Equipment requirements include wash rack, water pumps and hoses, steam hose, wet/dry vacuum and scrub brushes.

INSPECTION AND CLEANING PROCEDURES

- Prior to cleaning contaminated vehicles, equipment, and supplies are off-loaded
- Accessory items and palletized supplies are staged in a pest free zone for cleaning
- Vehicles or assets proceed to a steam or washing station as determined by inspectors
- Upon final inspection, material from mobile loads is reloaded aboard vehicles and the clean vehicles and supplies are re-embarked

Slide 5.1 – Course Completion

Congratulations, you have completed the retrograde wash-down lesson. Please click complete course to receive credit.