

Fumigants & Pheromones

Digital Newsletter Delivered by Insects Limited, Inc.

Issue 168

The Top 5 Stored Product Insects



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Stored product insects are insects that can infest whole grains, processed foods, and even tobacco. These insects can usually be found in grain silos, processing facilities, storage warehouses, retail stores, and even in our own pantries.

[Stored product insects](#) cause billions of dollars' worth of damage to the stored product industry each year.

Many can transmit molds and pathogens on their hairs and indentations on their exoskeletons to new areas. Internal feeders like weevils and the lesser grain borer can bore directly into whole grain kernels.

External feeders like flour beetles, warehouse beetles, cigarette beetles, and most food moths feed on damaged, out of condition grains, and processed foods. **This article will break down stored product insects into the top five most encountered species – the Indian meal moth, warehouse beetle, cigarette beetle, saw-toothed grain beetle, and red flour beetle.**

The number one most common stored product insect encountered throughout the world is the [Indian meal moth](#), *Plodia interpunctella*.

An adult Indian meal moth can be identified by a distinct two-tone pattern on the wings. The upper part of the wings contains a lighter tan / cream color while the lower part contains a darker copper / brown color. Larvae have no spots and are uniformly light cream, pink, or greenish color (depending on what type of food material they are feeding on).

Adult Indian meal moths will typically mate the first day of emergence. Females will lay 200 – 400 eggs for the next few days and live up to two weeks. A one-day delay in mating can reduce the number of eggs laid by 20%. Female moths fly from infested areas to uninfested areas to lay eggs due to an anti-egg laying pheromone chemical produced from the webbing of the larvae. The female can also detect food odors and lay her eggs near a food source in order to give her offspring the best chance of survival. Once an egg hatches, the first instar larva is small enough to invade packages through holes or gaps 100 microns wide (the same thickness as a dollar bill). Late instar larvae can chew through 25-micron cellophane, 100-micron kraft paper, and 100-micron PE plastic, though they usually start at product defects, seams, and folds. Adult moths do not have working mouthparts and all the physical damage caused to food product are from the larvae.

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The [Indian meal moth](#) can complete its life cycle in 20 – 60 days depending on temperature, humidity, and food availability. Stored product insects who have favorable conditions complete their life cycle at a quicker rate which allow populations to grow at an exponential rate causing infestations, product damage, and contamination that can then lead to recalls or negative brand image. Conversely, unfavorable conditions slow down the stored product insect life cycle which allow some of the insect life stages to live for a longer period of time but reduces the risk of infestation.



Figure 1. The Indian meal moth, *Plodia interpunctella*

[Pheromone monitoring](#) works well with the Indian meal moth and many other stored product moth species because males are strongly attracted to the female sex pheromone.

Stored product moths actively fly in temperatures above 65 degrees Fahrenheit and can fly over 1,000 feet in 10 minutes.

The traditional “[Indian meal moth pheromone](#)” not only attracts Indian meal moths, but also attracts over 20 other stored product moth species including the Mediterranean flour moth, almond moth, tobacco moth, and raisin moth.

Stored product beetles include species like red and confused flour beetles, cigarette beetles, drugstore beetles, warehouse beetles, and weevils. The second most common stored product insect is the [warehouse beetle](#), *Trogoderma variabile*. Warehouse beetles are in the family Dermestidae which include the Khapra beetle, carpet beetles, hide beetles, and larder beetles.

An important characteristic in the dermestid family is their unique larvae. Larvae have spear-shaped hairs called setae in which they use as a defense mechanism, similar to porcupine quills. Larvae molt about six times and leave behind cast skins. The setae on cast skins can easily contaminate food, cause allergic reactions, and irritations if ingested. A warehouse beetle larvae caused an FDA recall of 1 million packages of baby formula in 2010. Only one package was actually confirmed infested through a customer complaint. Dermestid larvae can be very long lived if conditions are unfavorable. Some dermestid larvae have been recorded to survive more than 5 years without food.

[Warehouse beetles](#) can be identified with their dark mottled color pattern with no scales. It can be difficult to distinguish the warehouse beetle between other insects in the same *Trogoderma* genus, such as the Khapra beetle. However, the Khapra beetle is unable to fly whereas the warehouse beetle can. Warehouse beetle and Khapra beetle share the same sex pheromone. A good way to distinguish between these two species is to place out [hanging pheromone traps](#) and [floor pheromone traps](#). If insects are only caught in floor traps and not hanging traps, then you may have Khapra beetle. The Khapra beetle is a quarantine pest and proper identification should be performed from a governing agency like the USDA.



Figure 2. The warehouse beetle, *Trogoderma variabile*

Warehouse beetles can complete their life cycle in 30 – 60 days depending on environmental conditions. They feed on dry grain based or high protein foods like corn, wheat, rice, and milk powder.

Adults generally orient towards warmer dry dark locations and can survive on residual food dust inside hollow block walls, or ceiling tiles. Adults live for 1 – 2 months and females can lay 100 eggs.

Third most common is the [Cigarette beetle](#), *Lasioderma serricorne*. Cigarette beetles can be distinguished from drugstore beetles by the many serrated teeth antennae. Drugstore beetles have three distinct elongated antennae. Cigarette beetles can complete its life cycle in 30 - 90 days depending on environmental conditions.



Figure 3. The cigarette beetle, *Lasioderma serricorne*

They are attracted to a wide variety of products including corn, potato, spices, wheat, milk powder, seeds, dry flowers, animal skins, and tobacco. Adults are shorter lived when compared to other stored product beetles and live for 1 – 2 months. Females can lay 100 eggs and once hatched, larvae can live on residual layer of spillage only 1 millimeter thick.

[Cigarette beetles](#) can fly when temperatures are above 70 degrees Fahrenheit and can be monitored with [hanging or floor pheromone traps](#). Cigarette beetles are attracted to a sex pheromone lure that is specific to the cigarette beetle.

Although [drugstore beetles](#) look very similar to cigarette beetles, they require a different pheromone lure.



Figure 4. The saw-toothed grain beetle, *Oryzaephilus surinamensis*

Fourth is the [Saw-toothed grain beetle](#), *Oryzaephilus surinamensis*. Saw-toothed grain beetles look very similar to merchant grain beetles. Distinguishing between these two species is difficult. The temple behind the eye of the saw-toothed grain beetle is wide and about the same width of the eye, whereas the temple behind the eye of the merchant grain beetle is narrow and less than half the width of the eye.

Both species are able to fly, but merchant grain beetle do rarely. Typically, saw-toothed grain beetles feed on more dry processed rice, cereals, grains, and dried fruits whereas the merchant grain beetle prefers more oily foods like seeds and bird food. Both the saw-toothed grain beetle and merchant grain beetle have low body profiles that allow them to invade packages through defects, gaps, and vent holes.

Saw-toothed grain beetles complete their life cycle in 30 – 50 days depending on environmental conditions. Adult beetles can live up to 2 years and females can lay 200 – 400 eggs. The saw-toothed grain beetle aggregation pheromone has been identified but is very costly to produce and unstable. Food attractants can be used as an alternative to lure and monitor saw-toothed grain beetle activity.



Figure 5. The red flour beetle, *Tribolium castaneum*

And rounding out at number 5 is the [red flour beetle](#), *Tribolium castaneum*. Red flour beetles can be distinguished from the confused flour beetle by enlarged last three segments on the antennae where the confused flour beetle has gradually larger antennae segments. Identifying between the red and confused flour beetle is important for mainly two different reasons. First, is the red flour beetle can fly where the confused flour beetle cannot fly. This information may be important in locating flour beetle infestations and how they are managed.

The second is that the red flour beetle egg can withstand higher fumigation concentrations than the confused flour beetle. Treating for red flour beetles could cost tens of thousands of dollars more than confused flour beetles.

The flour beetle can complete its life cycle in 20 - 50 days depending on environmental conditions.

They are attracted to a wide variety of dry food ingredients such as wheat, flour, cacao, dried milk, peanuts, beans, spices, and broken grains. Adult flour beetles can live for 6 months to 2 years and female flour beetles can lay 200 – 500 eggs. 10% of a flour beetle population are adults so when you see 10 adult individuals, you can assume there are 90 other flour beetles in a different life stage as an egg, larvae, or pupae. Both larvae and adults can live on residual layer of spillage that is only 1 millimeter thick.

Larvae prefer hiding in cracks and crevices and seek heat and darkness below food surfaces. Both male and female flour beetles are attracted to an aggregation pheromone.

Aggregation pheromone attracts both sexes to increase the probability that copulation will occur in the population. Aggregation pheromones do not work as well as sex pheromones, especially when compared to stored product moths, in monitoring programs.

It is important to Start with the Insect First!

Identifying the insect and understanding their biology is the first step to an effective integrated pest management program.

Once the stored product insect has been identified, inspect areas for ideal food sources such as foods, grains, seeds, or dried plant materials.

[Pheromone lures and traps](#) are great tools to monitor and help identify the source of infestation.

Finding and treating the source can help pest management professionals solve a difficult pest problem to help protect customers products and brand image.

If you have any stored product insect or pheromone questions, you can contact Ethan at E.Estabrook@InsectsLimited.com.

Start with the Insect First.

Insects Limited, Inc. is an insect pheromone company based on science, education, and innovation here to solve your pest problem.

We contribute to the pest management industry by providing cutting edge food safety and pest control information and effective pheromone products.

We actively look for ways to create new products that lead customers to save time and money in their insect monitoring program while giving them data and intel to make the right decisions after early detection has occurred.

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Issue 170

Stored Product Pests in the Food Distribution/Food Warehouse Setting



Brandon Oldham (CP-FS)
Sr. Corporate Food Safety Specialist

While a lot of focus is given to pest prevention and control in the production world, I want to move on down the chain of custody to warehousing and distribution.

There are a multitude of ways stored product pests and their issues arise in this setting.

Warehouses are high volume, high traffic hubs for products that come from all over the world.

They can house a vast variety of items.

This makes an integrated pest management system very complex and involved.

We can all agree that prevention is the best approach to pest management. Doing your part to be without, or to minimize exposure, is the most cost effective way to protect your reputation and prevent things like product damage, contamination, customer compensation, and worst of all, recalls.

Inbound inspection could arguably be the most important part of exclusion and prevention. Large vessels filled with massive quantities of sustenance that come from a vast array of environments and climates, could potentially be the perfect storm to triggering an infestation in your facility. Thorough product inspections being performed by trained individuals should be an integral part of your pest management program.

High risk product should be prioritized and heavily scrutinized, but **no trailer or shipment should be omitted**. All employees involved with the inbound process should, at the very least, have knowledge of what to look for.

- Insects and evidence of harborage and damage caused by them.
- Rodents and the indications of activity.
- As well as other signs of the product or trailer itself having been affected by poor sanitation and/or poor pest prevention practices from wherever or whoever the product is coming from.

Zero tolerance of any stored product pests and/or their evidence is best practice, but thresholds should be set to prompt rejections or corrective actions. Proper pest identification will help guide productive conversations around protecting the supply chain.

The Trojan Horse



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Training of employees can range from initial on-boarding/orientation training, to one point lesson communication. Utilizing employee engagement meetings and different kinds of visual media can help with that transmission. Real time, hands on experience is worth its weight in food as well. Employees being able to put their eyes on issues seen by other team members can create a positive pest exclusion environment, culture, and confidence in a support system.

The job isn't done here....



To make certain the product that has been inspected stays pest free, the probing must continue within the storage areas. As confident as your receiving team may be about their process and execution, sometimes things can be overlooked or, quite frankly, invisible to the naked eye at the time of receipt.

Exterior pressure, environmental pressure, seasonal pressure, and the fact that the common human is present, can all potentially expose the product stored in your warehouse as well.

All efforts should be made to close off any and all entry points from the outside world.

A preventative maintenance program (PMP) should include pest proofing activities. Things like door seals, dock leveler gaskets, screening on fans, vents, and drains should be in place and damage free. Walls, floors, and ceilings should be crack and crevice free so they can be easily cleaned to prevent any access or harborage areas. All these items need to be replaced routinely as part of the PMP. Good employee practices need to be communicated so actions can be monitored and accountability can take place. Leaving doors open, not cleaning up after one's self, or improperly performing sanitation duties could attract pests and trigger an infestation, whether it be from a food source, harborage initiator, or accidental introduction from the exterior.

Inspections of all areas of the warehouse are crucial. Trained eyes should be looking for all things mentioned during the inbound inspection process. Areas to inspect include; the warehouse as a whole (roofs, ceilings, floors and drains), utility rooms, office areas, break rooms, and other nooks and crannies conducive to pest activity. This includes drop ceilings and crawl spaces. Monitoring devices should be deployed strategically to help with these inspections.

Questions to Consider When Inspecting a Warehouse

- What pests are associated with the type of product you store?
- What pests are part of the ecosystem that surround your facility or exist in nature within your region, climate zone?
- Are there other businesses around your property that might naturally attract pest activity (farming, land fill, rail yards)?
- Do any of your employees bring bagged lunches, or have locker rooms where belongings from home are stored?

All these things should be considered when completing a pest assessment on your building. This pest risk assessment is to be utilized to decide what type of monitoring devices are needed and where they should initially be placed. Other assessments might be done after inspection. Monitoring device data is recorded over time so high pressure areas can be inspected appropriately and corrective actions can help minimize activity.

Sanitation should be top priority when handling food, as it also goes hand-in-hand with pest prevention. In a lot of ways sanitation is pest control. Having a sanitation program, including both the interior and exterior of the building, eliminates food sources and harborage material. Cleaning in and around your warehouse also helps make inspections much easier. It is much easier to find pest evidence with a floor or ground space free of product, debris, and dust/dirt. Whether this be droppings, urine, webbing, cast skins, or the pest itself. Sanitation work can also uncover things needing to be fixed by maintenance.

Preserve Your Reputation

Outbound inspections are your last chance to be proactive in most cases. Just as trained individuals are responsible for bringing clean product in, trained individuals need to verify the product stayed pest free while in possession of it. This is done by inspecting before loading for shipping. There needs to be an inspection of the conveyance vessel. This guarantees it is in sound condition, without contaminants that will expose the product while loading or while being transported to its destination. Just like inspecting your facility, ensure the container has no passage to the exterior through cracks, holes or damage to door seals.

In all steps mentioned throughout this article, we need to make sure that records are created, filled out completely, and retained. Examples being; inbound inspection reports, facility inspection reports and monitoring device data, outbound inspection reports, training records, rejection records, sanitation records, and 3rd party reports whether it be pest control or outside cleaning companies. **If it's not written down it never happened.** These documents can all help provide clarity as to where a problem with pests may have started, and could potentially keep your company's name out of the negative headlines. Having these documents will also support/guide corrective actions with vendors or help deflect or denounce blame from a customer or consumer.

In summary, protecting your storage facility from pests is just as important as protecting a production facility. In many cases, warehouses store product from multiple vendors. If a problem presents itself within that warehouse it could potentially damage the reputation of many brand names, regardless of fault. In every case, the cost of a well-run, dynamic pest prevention program will always cost less than an infestation, especially one that has customer or consumer impact.

The following are images courtesy of by Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist

Examples of Rodent issues:



A living mouse inside a food package –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist



Mouse droppings on food containers –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist



Large amounts of rodent droppings on an incoming trailer –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist

Examples of Insect Issues:



Indianmeal moth webbing and feeding on birdseed –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist



Red-legged ham beetle emerging from a punctured package –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist



Beetles inside a package of rice –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist



Cigarette beetles in a package of pasta –Brandon Oldham (CP-FS), Sr. Corporate Food Safety Specialist

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The Red-Legged Ham Beetle, No friend of hams, and even worse friend of pet food



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When a deer falls dead in the forest does it make a sound? Yes, and it is that of insects, who are quick to the scene.

Decomposition in vertebrates is a complex process involving several (pretty gross) stages. A dead deer starts off as fresh for a while, depending on temperature, but as bacteria in the gut start to turn on their former host, the body starts to bloat and break down from the inside. It's not long after this that the insects really get to work breaking down tissue, and consuming fluids, all while being pretty gross about the whole thing.



Deer and other animal carcasses, are the RLHB's natural food sources. Note: No deer were harmed (recently) for this photo

It's wet and smelly work but someone has to do it. Over time, as the process advances, the wetness begins to dry, the maggots turn into flies who leave for more rotten pastures, and the "good bits," so to speak, are all gone. What's left is a mostly dry, partially skeletonized, carcass with some jerky-like bits left over. This is the point where the [Red-legged ham beetle](#) (*Necrobia rufipes*) makes its entrance.

Red-legged ham beetle (RLHB for short) is about a quarter of an inch long, and has iridescent green wings, and dark orange legs. Apparently, orange-legged ham beetle didn't have the same ring...

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The adults of these insects are quick on their feet as well as very capable fliers. Effective flight is a necessity when scouting out ephemeral food sources like dead animals. What’s more, these insects are also good competitors of other insect larvae. Adult RLHB will happily eat the larvae of other species that compete for the same resources such as Dermestid beetles or left-over fly larvae still trying to feed on any wet bits that remain. While the name “[red-legged ham beetle](#)” suggests that they are primarily a pest of hams, they are in fact, currently emerging as far more problematic in the pet food industry. Their natural habitat and food source equips them with the right tools to be a real headache in pet food manufacturing, distribution, and retail settings. Most pet food items are meat-based. Some are even exact analogs for their natural food source. Think about the aisle at the pet food store containing open boxes of meaty bones for dogs and meat-based dried food. These “treats” and food products replicate the exact stage of decay that these beetles thrive on. What more could they want? In fact, pet food retail stores do one better for these beetles. In the wild, these beetles will pupate in fur, cracks, and crevices in or around an animal carcass. Pet food retail stores have an abundance of cracks and crevices as well as fuzzy, “fur-simulating” objects like tennis balls and other dog and cat toys.



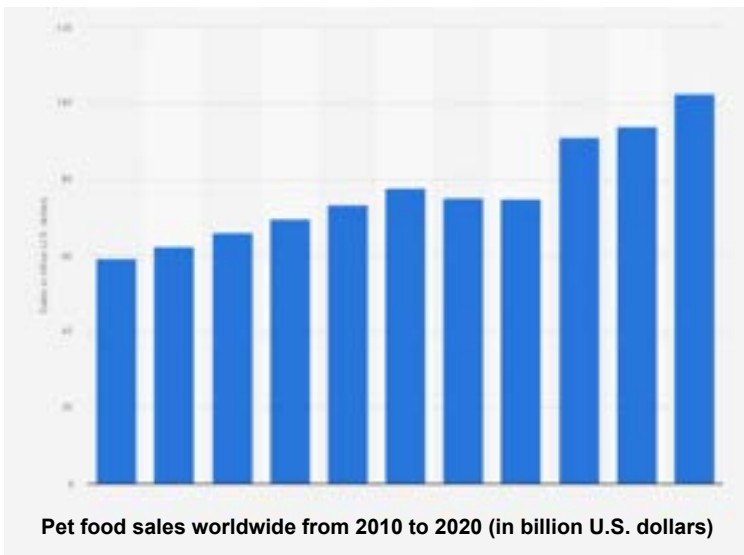
Fuzzy tennis balls are one of the RLHB favorite spots to pupate in a pet store. Fun Fact: Like Butterflies, RLHB are one of the only beetles to pupate inside a silk cocoon they make themselves!

Their excellent flight capabilities help them find and colonize pet food items.

Their competitively predatory nature helps them kill their competition, and their ability to hide and pupate in unexpected places can help them avoid treatment.

It is no wonder at this point why they are becoming a real hassle. The pet food industry continues to grow.

From 2010-2020 pet food sales rose 43.3 billion dollars from 59.3 billion in 2010 to 102.6 in 2020.



Some expectations are that global pet food sales could reach over 160 billion dollars by 2029.

This increase in sales and pet food manufacturing demand will mean more food for RLHB and more opportunities to spread through ever-widening supply chains. We should expect in the coming years that even more attention to be given to this damaging pest in the form of additional research, monitoring, and treatment options.

That being said, it’s about time for me to get back to the lab and do just that!

Pheromone Traps for Red-Legged Ham Beetle

Red-Legged Ham Beetle Kits feature Insect Limited’s signature pheromone lures that use a pheromone mixed into a food attractant to draw in Red-Legged Ham Beetle, *Necrobia rufipes* over a 3-month period.



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Issue 171

Implementing a Pheromone Monitoring Program



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Grain storage, food processing, warehousing, retail facilities, and residential houses are far too diverse to expect a single set of pheromone monitoring recommendations to be adequate.

Here are 4 fundamental questions to ask when developing a pheromone monitoring program:

1. What type of pheromone monitor should I use?
2. How many pheromone monitors are necessary?
3. Where should pheromone monitors be placed?
4. How often should pheromone monitors be serviced?

What type of pheromone monitor should I use?

It is important to [Start with the Insect First!](#)

Identifying the insect and understanding their biology is the first step to an effective integrated pest management and pheromone monitoring program. Insect species have specific pheromones so using the correct pheromone lure for your target species is especially important.

For example, [cigarette beetles](#) and [drugstore beetles](#) look very similar but require different pheromone lures to monitor. Knowing the species also helps determine what style of trap to use.

[Hanging pheromone traps](#) work well with strong flying insects like the [Indian meal moth](#) or [Mediterranean flour moth](#).

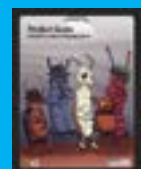
[Pitfall traps](#) placed on the ground, work well with crawling insects like many of the beetle species but are more vulnerable to getting lost or damaged.

As for the best [pheromone traps](#) - test them for yourselves and see which works best for you.



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How many pheromone monitors are necessary?

Typically, there is a positive correlation between food product value and the number of pheromone monitors deployed. A 10,000-square-foot seed warehouse will probably have fewer pheromone monitors than a 10,000-square-foot warehouse storing baby formula. Many quality control managers and pest control operators place pheromone monitors 50 – 150 feet apart in food processing facilities. The facility size, number of floors, complexity of the trapping environment, and temperatures are all conditions that can influence how many pheromone monitors are necessary. The number of pheromone monitors at a facility ultimately depends on the overall objective of the pheromone monitoring program.

Where should pheromone monitors be placed?

Place one or two pheromone monitors per area in areas such as a pantry or home. In commercial areas, such as warehouses or retail stores, place hanging pheromone monitors every 50 – 150 feet apart for strong-flying insects and floor pheromone monitors every 25 – 50 feet apart for crawling insects. Pheromone monitor density can be increased or decreased based on insect activity and how closely you want to monitor for insects. Hang pheromone monitors at eye level, where they will not be damaged, that allows easy access to inspect for insect captures. Ventilation, open doors, machinery producing heat, and air currents will affect the shape and size of pheromone plumes being emitted from the pheromone monitor. Keep pheromone monitors 15 -25 feet away from exterior doors to help prevent the attraction of outdoor insects into the facility.

How often should pheromone monitors be serviced?

Generally, pheromone monitors should be serviced on a 7 or 14-day schedule. Many stored product insects complete their life cycle within a month, so a monthly service visit only collects one data set per generation. Many things can change within a facility over long service intervals such as turnover of food products, changes in weather, and sanitation conditions. Service all traps and lures on the same day to help enable direct comparisons of capture among pheromone monitors. How often lures should be changed depends on the type of pheromone lure and the manufactures guidelines. Most pheromone lures should be changed out every 2 – 3 months.



Implementing pheromone monitors into an IPM program can identify valuable information about insect activity, such as the detection of insects, insect species, population trends, and locations of infestations. [Pheromone monitors](#) are meant to be used as a monitoring tool as part of an integrated approach to pest management. By themselves, pheromone monitors do not eliminate an insect outbreak. With the information from pheromone monitoring, inspection, increased sanitation, and removal of infested material, control of stored product insects can be achieved. If you have any stored product insect or pheromone monitor questions, contact me at E.Estabrook@InsectsLimited.com.

