Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Khapra Beetle Program Manual

Photo courtesy of: Sindhu Krishnankutty, USDA-APHIS-PPQ

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When using pesticides, read and follow all label instructions.

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Introduction

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Purpose of the *Khapra Beetle Program Manual*

The APHIS PPQ Khapra Beetle Program Manual is intended to provide information to guide PPQ Field Operations and cooperators in the following areas:

- Survey and sampling to detect isolated infestations at low population levels
- Eradication efforts on isolated infestations
- Prevention of human assisted spread of khapra beetle to **non**infested areas

Background

The khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae), is a destructive pest of grain, seeds, and stored food products. Additionally, food products infested by khapra beetle pose a threat to humans as hairs and cast skins from larvae are known allergens and a respiratory hazard. Originally native to the Indian subcontinent, it has expanded into other parts of Asia, Africa, and Europe.

Khapra beetle and associated host material are regulated by the USDA under authority of 7 CFR 319.75. While khapra beetle is **not** known to occur in the United States, interceptions at ports of entry are common and the pest risk potential of khapra beetle is high. If khapra beetle were to

become established in the United States, it would pose a significant threat to the domestic grain industry in terms of yield losses, but more consequentially it would impact the $10+ billion United States grain export market. The goal of routine survey efforts is to monitor high risk areas for detection of isolated populations to help ensure the United States remains free from khapra beetle.

Biology and Ecology

Lifecycle

Khapra beetle has four life stages; egg, larva, pupa, and adult. Females may lay up to 100 eggs during their lifetime. Eggs are very small and translucent, making them difficult to detect. Eggs usually hatch in 3 to 10 days, depending on temperature and humidity.

Khapra beetle spends most of its life in the larval stage and nearly all of its feeding occurs during this stage. The number of larval instars is indeterminate, as development is influenced by temperature, food availability, and crowding. Under favorable conditions, the larval period is 20 to 40 days. However, khapra beetle frequently enter dormancy during later stages of larval development.

During dormancy, development is paused in response to adverse conditions such as overcrowding, low temperature, low food quality, and/or lack of food. The dormancy of khapra beetle larvae is usually referred to as a facultative diapause, where molting and feeding occur sporadically, but development to the pupal stage **does not** occur. In the absence of food, diapausing larvae have been observed to survive for several years.

The pupation period usually lasts 4 to 6 days. The adult is short lived, typically for 1 to 2 weeks. One to ten generations of khapra beetle may occur per year. Under favorable conditions, khapra beetle can complete development in as little as 26 days. Under less favorable conditions, diapause in the late larval stage is common though larvae may resume development and pupate when favorable conditions return.

Khapra beetle is best suited to hot and dry climates, but they are tolerant of both extreme cold and heat. Optimal temperature for development is around 30 °C. At temperatures below 20 °C or above 35 °C development is halted. Khapra beetle endures adverse conditions as late-stage larvae in diapause. Diapausing larvae are less susceptible to fumigation treatments due to reduced metabolic activity. They can also be difficult to control with contact insecticides as they frequently seek refuge in cracks or crevices that are hard to reach.

Infestations

Khapra beetles live in stored grains and other plant and animal products. Hairy larval skins (exuviae) found in grain can indicate that there is an infestation. Live insects are usually in the top 50 cm of the grain pile. Larvae tend to aggregate in cracks, corners, and other tight spaces in storage facilities, shipping containers, or other structures without large available food sources.

Khapra beetles can feed on a wide variety of dried plant and animal products. This includes important commercially traded grains and other commodities such as wheat, barley, rice, peanut, cowpea, dried distiller’s grain, and sorghum. Khapra beetles may also feed on processed products such as dog food, protein drink mix, ground grains, tapioca, dried fruits, pasta, and

cereal among others. Animal products like powdered milk, dried blood, dried animal skins, and fish meal are also known to serve as food sources.

Khapra beetle population growth is dependent upon host food, as well as environmental conditions (temperature, humidity) and crowding. Larval development is usually faster when foods with higher protein content are available. For example, population growth is typically higher on wheat compared to barley or rice. Similarly, processed foods such as dog food or protein shake mix can provide excellent food sources for khapra beetle.

Pathways of Introduction and Dispersal

Khapra beetle has been intercepted at ports of entry in mail, stores, general cargo, and permit cargo; however, the majority are found in passenger baggage. In recent years, the number of detections of khapra beetle has increased, prompting greater concern for the potential of establishment. This is due to an increase in the number of travelers from countries where khapra beetle is present, along with efforts to train inspectors and improve targeting of inspections.

Khapra beetle adults are flightless, and the movement of adults and larvae is limited to short distances. Infestation of grain stores or other products from the surrounding environment is unlikely. Therefore, the spread of khapra beetle to new areas typically occurs through the movement of host commodities. Spread at a local level may occur on items such as bags, clothing, or in stored products. Over long distances, the pest is spread mostly by humans in commerce and trade, through household moves, and in personal baggage containing dried food products. Movement of grain and seed products or contaminated machinery can also spread khapra beetle. These infestations present the greatest risk for spread into the domestic grain supply where trade could be impacted.

Advisories

Advisories are used throughout the *Khapra Beetle Program Manual* to bring important information to your attention. Please carefully review each advisory. The definitions coincide with American National Standards Institute (ANSI) [1] and are in the format shown below.

⚠ CAUTION

CAUTION is used to indicate tasks involving minor-to-moderate risk of injury.

⚠ DANGER

DANGER is used to indicate the event of imminent risk of death or serious injury.

NOTICE

NOTICE is used to alert a reader of important information or Agency policy.

[1] TCIF Guideline, Advisories *(Safety-Related Warning Message)*, TCIF-99-021 Issue 1, p.4.

SAFETY

SAFETY is used for general instructions or reminders related to safety.

⚠ WARNING

WARNING is used to indicate the event of possible risk of serious injury.

Khapra Beetle Program Manual Contacts

Information Services and Manuals Unit (ISMU)

The PPQ Information Services and Manuals Unit (ISMU) issues and maintains manuals electronically on the Plant Health Domestic Program and Emergency Response Manuals webpage.

If you are unable to access the *Khapra Beetle Program Manual* online or have a suggested edit (layout, spelling, etc.) please contact ISMU by email at PPQ.IRM.ISMU.Manuals.Feedback@usda.gov.

Revisions to the manual are announced via the APHIS Stakeholder Registry to government employees and external stakeholders who have subscribed to receive *Khapra Beetle Program Manual* updates. To subscribe, navigate to the APHIS Stakeholder Registry, enter your email address, and select the relevant manuals under Plant Health Information – Manual Updates.

Khapra Beetle Program Manual Liaison

If you disagree with a policy or procedure or have a situation that requires an interpretation or application of existing policy, you can contact the PPQ National Policy Manager at anne.lebrun@usda.gov.

Chapter 2

Survey and Trapping

Contents

Introduction

This chapter provides instruction on how to complete surveys for khapra beetle. Early detection surveys are necessary to find small khapra beetle populations in a timely manner. This ensures that PPQ is able to eradicate the infestation before khapra beetle becomes established locally and ensures trade is **not** impacted. Delimiting surveys are used to define the extent of infestation and to guide programmatic response. Monitoring surveys are used to determine if treatment is successful and to ensure that the location remains free of khapra beetle for an established amount of time after the initial find.

To ensure that khapra beetle surveys detect early populations and provide reliable negative survey data, it is critical that the surveyor follows the guidance in this chapter and the Identification chapter. This chapter provides guidance on how to properly plan and conduct a khapra beetle survey.

Selecting Survey Locations

Use the following information to select the highest risk locations to survey in your state. Since staffing resources are often limited, you may need to rotate surveys through different locations each year.

Use locally available resources to assist you in identifying high risk sites of introduction/interception. Local PPQ Smuggling Interdiction and Trade Compliance (SITC) staff are a good resource to identify high risk products, as well as importers, distributors, and retailers in the area. Your local U.S. Customs and Border Protection (CBP) contacts can assist with finding high risk locations as well. In addition, you may want to include locations that have received Emergency Action Notifications (EANs) for khapra beetle.

Use the following list as a starting point to identify areas of potential risk in your state in conjunction with the input from your local SITC and CBP counterparts:

- A commercial location that is the known, intended destination for a shipment of host material that CBP found to be infested by live khapra beetle at the port of entry. Previous shipments from the same supplier are possible and may have entered without inspection.
- Air cargo warehouses at international airports. These warehouses belong to individual airlines that service that airport. The warehouses often receive household goods and other materials that may be a pathway.
- Coffee roasters that import coffee beans in used burlap bags from khapra beetle countries
- Distribution warehouses for companies that sell high-risk merchandise
- Express consignment facilities (DHL, FedEx, UPS, etc.) or other facilities where potentially infested materials may pass through
- Grain dealers. If there is a known pathway for introduction of khapra beetle, or if in proximity to a known or possible pathway, then these sites may be considered much higher risk.
- Importers of brassware or other products from khapra beetle countries packaged in burlap bags
- Importers of bulk grains and spices from khapra beetle countries. Importers who repackage these products within the warehouse for retail distribution are highest risk. Examples include but are **not** limited to dried chickpeas, cracked corn, cracked or bulghur wheat, and hibiscus.
- Importers of manufactured, processed, or otherwise prepackaged host material that is ready for retail sale from khapra beetle countries
- Military facilities where returning luggage or household goods are stored
- Retail markets selling materials outlined above
- Transload facilities, locations where container cargo is transferred from one load unit to another. When a container is transloaded, it usually occurs at a facility that is close to a

port terminal. A container will be taken into a facility and transferred to a domestic container or truckload.

Trapping

Trap Placement

Survey a new facility with a company representative, if possible, to identify locations before placing traps. Check exit and entry areas, as well as any storage locations on the premises. Observe the movement of products, containers, and/or people handling products which could have been exposed to khapra beetle.

Be alert for cartons, burlap or jute sacks, debris, woodwork, cracks, loose plaster, loose paint, and other such hiding places. Carefully inspect rodent bait stations and other such traps with grain or cereal. Khapra beetles are attracted to dirty grain and storage or handling facilities; conversely, sanitary conditions are a deterrent. Areas of low light are also favorable for khapra beetle.

In empty bins and warehouses, larvae are likely to be in or on ledges, cracks in the floor or walls, old cartons, rags, sacks, newspapers, scrap lumber, or other debris. Elevator tunnels also serve as hiding places for khapra beetle larvae. When inspecting sacked material, the ears and seams of bags are common hiding places for the beetle and should be inspected. In bulk storage where heavy infestations may occur, larvae tend to congregate in the surface grain and on or near the walls. Look for cast larval skins as a sign of an active infestation.

When to Trap

Conduct surveys when average temperatures are above 70 ºF in the trapping environment. Survey outdoor areas throughout the warm season. Environmental conditions may be less severe than prevailing weather conditions in areas immediately surrounding ports and grain processing and storage facilities. Use practical judgment to determine if temperatures are warm enough. In more temperate areas, conduct surveys from mid-May through mid-September. In heated warehouses, food storage and processing areas, dwellings, and other moderated environments, surveys with traps are appropriate at any time of year.

Trapping Supplies

The Khapra Beetle Wall Mount Trap Kit contains all supplies necessary to complete a khapra beetle survey. The kit includes:

- Six khapra beetle wall-mounted traps (Figure 2-1)
- Seven khapra beetle pheromone lures (Figure 2-2)
- Organic wheat germ (the food bait for the beetle) (Figure 2-3)
- Plastic collection tray for wheat germ (Figure 2-4)
- One decoy sticky trap (Figure 2-5)

The wall mount traps may be reused.

Use the decoy aerial trap to capture warehouse beetle, *Trogoderma variable* Ballion adults and minimize their numbers in khapra beetle wall traps. The warehouse beetle is often present in warehouses, and it is difficult to distinguish between warehouse beetle and khapra beetle. Since

both species are attracted to the same pheromone lure, warehouse beetles may overwhelm khapra beetle traps. However, since the warehouse beetle is a strong flyer, unlike khapra beetle, which **does not** fly, use the aerial decoy trap to minimize or exclude warehouse beetles collected in khapra beetle wall traps.

Fit the decoy aerial trap with one of the khapra beetle lures and hang it high in the open head space of the building. Use one aerial trap for every five to six khapra beetle wall-mounted traps.

Figure 2-1 Khapra Beetle Wall-Mounted Trap

Figure 2-2 Khapra Beetle Pheromone Lure

Figure 2-3 Organic Wheat Germ

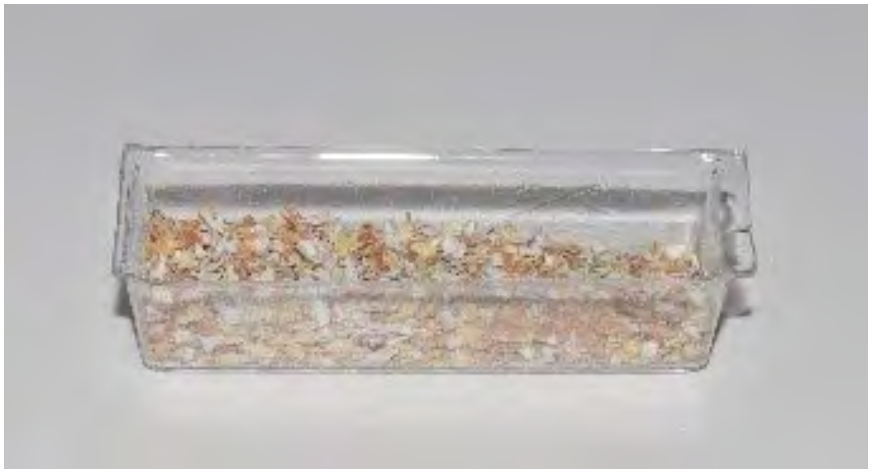

Figure 2-4 Plastic Collection Tray with Wheat Germ

Figure 2-5 Decoy Aerial Trap with Khapra Beetle Pheromone Lure

Additional Supplies (Locally Available)

- Aspirator or vacuum collection device (may be sourced from vendors such as BioQuip Products)
- Brightly colored flagging (to help you find traps for return visits)
- Cooler with ice packs
- Disposable gloves (for sweep sampling)
- Double-sided tape or another adhesive (Gorilla brand tape works well)
- Dust mask (for sweep sampling)
- Forceps
- Hard hat
- Headlamp
- Labels for samples
- Orange safety vest
- Permanent marker
- Pencil
- Plastic bins to store and provide easy access to equipment
- Plastic resealable bags (sandwich and gallon sized)
- Small paintbrush for brushing insects out of the trap
- Wipes or paper towels to clean the wall surface before hanging traps

Trap Set Up

Follow the instructions from the manufacturer that are included with the trap kit to assemble the traps. Use a permanent marker to label each trap with a unique identification number, for instance County Code-Facility Code-Trap Number. Use the wall mount trap inside and outside structures. Place traps around the inside of exterior walls and along interior walls of structures under investigation (Figure 2-6). Pay special attention to cracks in the walls and walls made of

porous materials like cement blocks. Cracks may serve as pathways for insect movement. If possible, place a trap over a wall crack if one is found.

Figure 2-6 Correct Placement of Khapra Beetle Trap

Clean the wall thoroughly before attaching the trap to the wall. An alcohol prep pad or paper towel soaked with ethanol works well to clean the wall. Allow the wall to dry before affixing the trap to the wall. You may use any locally available double-sided foam tape (Gorilla brand, 3M, double-sided foam tape, etc.). Duct tape **does not** work well for this purpose. Replacing the tape is often necessary when servicing traps. **Do not** cover the entry holes on the back of the trap. Use an opened paper clip to open the side tabs, which may **not** be perforated completely. When attaching the trap to the wall, make sure that all four back entry tabs are in contact with the wall and that the trap is also attached loosely enough so that entry holes are **not** closed (Figure 2-7). These are the places where the larvae will enter the trap.

Be aware that the trap adhesive or tape (if used) may remove some paint from walls when the trap or tape is removed. Let the facility know this. You may need to choose a less prominent location.

Figure 2-7 Wall Trap with Back Entry Tabs Opened Correctly

Fill the plastic collection tray with wheat germ (Figure 2-3). Fill the dish **only** 1/4 to 1/3 full, being careful **not** to spill wheat germ in the trap, and keeping it vertically oriented after assembly through attachment to the wall.

Areas to Avoid

Areas exposed to human activities such as sweeping, foot traffic, or frequent use of mechanized equipment may lead to trap loss. Placement in very oily or damp locations will lead to trap damage or poor adhesion. Slippery surfaces, such as metal, plastic, glossy painted concrete, or glass walls may inhibit khapra beetle movement.

Height

Mount traps as low as possible to maximize captures. However, in most cases, to avoid trap loss from maintenance activities, mount the traps at least above broom height. Look for locations up to about two feet off the floor where they can be easily serviced.

Density

Allow 25 to 40 feet between traps or base the placement of traps on the layout of buildings. The more traps that are set, the greater the chance of finding khapra beetle, if present. However, if there are too many buildings and travel is a problem, half of the locations can be trapped in alternate years. This way, a building can be more intensively trapped, thus increasing the chances of finding khapra beetle.

Survey Supply Procurement

Order all traps and lures through the IPHIS Survey Supply Ordering System. Follow the national guidance for procuring traps and lures during the two ordering open periods each year. If you need immediate assistance, contact Laurie Morales at laurie.m.morales@usda.gov or 970-494-7535 or Darrell Bays at darrell.a.bays@usda.gov or 919-500-9959.

When ordering the trap kits, be sure to order additional lures so that you can change out the lures during the trapping season.

Product Names in the IPHIS Survey Supply Ordering System

- Khapra Beetle Wall Mount Trap Kit (includes six traps and seven lures)
- Khapra Beetle Lure (additional lures that can be ordered)

If you need to purchase additional organic wheat germ, it may be purchased locally; **however, it must be organic wheat germ**.

Trap Servicing and Sample Collection

Check traps every one or two weeks. When inspecting the trap, dump the contents of the plastic collection tray (including the wheat germ and any insects) into a resealable plastic bag. Inspect the trap for any other larvae that have **not** yet reached the collection tray. You can do this by tapping the tray into the plastic bag and using a fine paintbrush to dislodge any insects into the tray. Place a label on or inside each bag with a unique trap identification number, date of location, and facility name. Place the bag in a cooler with ice packs.

NOTICE

It can be difficult to remove the wheat germ tray when servicing the trap. If this is an issue, the entire trap may be removed at each sample collection, and a new trap placed.

Refill the plastic collection tray with fresh wheat germ. **Do not** dispose of used wheat germ onsite. Even if there are **no** visible insects present in the wheat germ, bring the used wheat germ back to the lab/office for proper disposal. Refer to the Identification chapter for further information.

The khapra beetle lure is effective for 28 days. Change lures in both the khapra beetle and decoy traps every 28 days.

When checking a trap for the last time and removing it, place the complete trap in a resealable plastic bag. Place a label inside the bag with a unique trap identification number, date, and facility name.

Before leaving each facility, wipe down any tubs or containers that you brought into the facility with a lab wipe or paper towel soaked with ethanol. Clean your boots and clothing well before traveling in the government owned vehicle to avoid tracking khapra beetle life stages to other locations.

Sample Preparation and Storage

Keep specimens as cool as possible. Transport samples back to the lab in a cooler. At the lab, if samples **cannot** be sorted and screened immediately, store the samples in a freezer. Place the entire plastic bag with the trap contents in the freezer. For samples taken from the last trap servicing of the season, freeze the entire trap inside a plastic bag. This will prevent sample degradation and the potential for larvae or adults to escape into the lab. Larvae otherwise may degrade to the point where they are difficult to find within sweepings or food baits. Such precautions will also help with potential visual or molecular identification.

Refer to the Identification chapter for instructions on sample sorting, sample screening, specimen routing, and taxonomic guidelines.

NOTICE

The manufacturer's instructions mention rearing out of specimens. **DO NOT** rear out suspect khapra beetle eggs or larvae from PPQ, Cooperative Agricultural Pest Survey (CAPS), or Plant Protection Act (PPA) 7721-funded khapra beetle surveys.

Survey Records

Enter survey records into the Integrated Plant Health Information System (IPHIS) under the template Khapra Beetle Detection. The types of data that will be collected are location, date, host, activity (install, remove, or trap check), and lure.

Chapter 3

Identification

Contents

Sorting and Screening

Sort and screen trap collections before submitting specimens for identification. Sorting raw trap samples requires familiarity with insect groups and experience in examining specimens. Sorting is the first level of activity that assures samples submitted are of the correct target group of pests being surveyed. Sorting samples in a khapra beetle survey involves removal of **non**-beetle specimens.

Screening is removing obvious beetle larvae or adults **not** fitting the general descriptions of dermestid or similar-looking beetle families. Screening in a khapra beetle survey involves removal of **non**-dermestid beetles before specimens are submitted to a PPQ Identifier.

NOTICE

Microscopes with 10X–15X magnification are recommended for sorting and screening.

Freeze samples according to the directions outlined in Survey and Trapping. Pour the frozen contents of the trap onto a lab tray. Remove wheat germ and other debris. Remove insects that are **not** beetles. To the best of your ability, remove any beetles that are **not** in the Dermestidae family. When in doubt, keep the insect in the final sample to be submitted.

NOTICE

A small paintbrush moistened with alcohol is useful for moving suspect specimens from the sample to a vial without damaging the specimens.

The following linked module, developed for Customs and Border Protection Agriculture Specialists, provides useful background on sorting and screening of domestic survey samples: Dermestid Beetle Recognition and Screening Aid.

Whenever an entire trap is removed and replaced, such as during the last trap servicing of the season, thoroughly inspect for larvae that may be hidden inside. Gently dismantle the trap and

inspect the corrugated cardboard and the entire interior of the trap. Khapra beetle larvae are attracted to the corrugated cardboard, and specimens may be found within the folds of the cardboard. Separate the corrugated cardboard to examine for larvae within the folds. Use a fine paintbrush to dislodge any insects from the cardboard. If the specimen is caught in adhesive, cut the insect out of the trap with scissors so that **only** a small piece of trap backing remains.

The following resources are useful guides for identification of suspect specimens from sorted or screened samples:

- Dermestidae Adults Self-tutorial
- Dermestidae Larvae Self-tutorial

If the trap was **not** previously frozen, place the entire trap in a freezer for 15 days before disposal or reuse after the trap has been inspected. The majority of household freezers maintain temperatures from -9 °F to 0 °F. Likewise, freeze any used wheat germ for 15 days before disposal, even if suspect specimens are **not** found.

Place insect larvae and adults in vials with **nondenatured** 95% or higher ethyl alcohol.

NOTICE

The manufacturer's instructions mention rearing out of specimens. **DO NOT** rear out suspect khapra beetle eggs or larvae from PPQ, Cooperative Agricultural Pest Survey (CAPS), or PPA Section 7721-funded khapra beetle surveys.

Specimen Routing and Taxonomic Guidelines

Identification of dermestid beetle larvae or adults recovered from khapra beetle survey traps is difficult and requires specialized training. State or PPQ offices given the responsibility for this survey should consider the ability, experience, and expertise of those assigned to the various steps of sorting, screening, and identification of trap samples to ensure quality data is collected.

Qualified state, county, or cooperating university personnel can screen and perform tentative identification of suspected khapra beetle specimens. The specimens **must** be forwarded with a completed PPQ Form 391 to a PPQ domestic identifier. (Many PPQ port identifiers are skilled at identifying *Trogoderma granarium*, but their workloads normally **do not** allow processing of domestic samples). Suspect *Trogoderma* spp. going to a domestic identifier should be entered into the Agricultural Risk Management system (ARM) by those who have access. The domestic identifiers can also enter these records if necessary for samples going forward for final confirmation.

The domestic identifiers listed below will accept specimens for possible dissection, forwarding to the USDA Systematic Entomology Laboratory for final confirmation, and logging into the ARM database.

Before initiating delimiting surveys and/or control activities in the United States, a specialist recognized by USDA-APHIS-PPQ National Identification Services (NIS) **must** confirm the specimen is khapra beetle. All *Trogoderma* species that are **not** khapra beetle will be recorded as *Trogoderma* sp. (**not** *T. granarium*). All specimens that NIS morphologically confirm as khapra beetle collected during domestic surveys require molecular confirmation.

For confirmatory identification, follow the steps here: Request Official Confirmation of Preliminary Pest Identifications of Domestic Samples.

Prior to each survey season (fall/winter), confirm by phone or email with the identifier that they have the capacity to process your sample(s). Include the following information:

- Expected number of samples for the survey season
- Name and email of person who will be submitting samples

Always notify the identifier that samples are being mailed along with the following information:

- The number of samples and how many adults and larvae in each
- The shipment's tracking number

For the Eastern States, both PPQ surveyors and/or state taxonomists may send screened specimens (Dermestidae) to:

Bobby Brown
Department of Entomology, Purdue University
Smith Hall
901 W. State Street
West Lafayette, IN 47907-2089
robert.c.brown@usda.gov
Phone: 765-496-9673

For the Western States, both PPQ and/or state taxonomists may send screened specimens (Dermestidae) to:

Xanthe Shirley
USDA, APHIS, PPQ
2771 F&B Road, Building 2, Room 105
College Station, TX 77845
xanthe.a.shirley@usda.gov
Phone: 512-383-2474

For States with **no** taxonomist and/or screening ability, the domestic identifiers can accept sorted or screened samples with prior arrangement. Contact the National Operations Manager for Khapra Beetle to arrange taxonomic assistance (feridoon.mehdizadegan@usda.gov).

Results Reporting

Negative results from identifiers will be communicated directly back to the submitter. Morphological determinations of "*Trogoderma* sp. (**not** *granarium*)" are considered negative results. **No** additional information is required for specimens with final determinations of "*Trogoderma* sp. (**not** *granarium*)." Any suspect positives going to SEL for molecular confirmation will be communicated via the PPQ Domestic Diagnostics Coordinator to the khapra beetle cross functional working group members as well as the State Plant Health Director and State Plant Regulatory Official of the state of origin.