

Science-Based Solutions for Large Flies

The Outside-In Approach

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Ecolab Pest Elimination



INTRODUCTION

House flies, blow/bottle flies and flesh flies (referred to as Large flies) are common pests in and around human habitats¹. They are considered synanthropic because they benefit from this close association with humans. This group of flies are also referred to as ‘filth flies’ due to their association with garbage, decaying organic material, feces and rotten meat.

Large flies have been associated with the spread of disease pathogens for Cholera, Typhoid Fever, Diphtheria and Dysentery. These pests have been shown to transfer foodborne illness agents including *E. coli* and *Salmonella*.² This association with pathogens makes these common pests unacceptable guests where we live. This is especially true for places where food is prepared, packaged, served and eaten. Minimizing the presence of large flies in commercial food handling locations is a critical part of food safety.

Large fly activity in commercial structures is best managed using an **Outside-In Approach**. This is done by establishing three layers of protection.

1. **Exterior** – reduce large fly pressure on the outside
2. **Barrier** – minimize large fly entry into the structure
3. **Interior** – rapidly remove large flies from within the structure

Each of these layers of protection is an important part of an integrated approach to maintaining a fly-free structure and reducing the risks associated with large flies.

OBJECTIVES

The objective of this paper is to review current knowledge and science on large flies and their behavior around human structures. Science-based recommendations and procedures to minimize large fly activity and the risks they pose inside commercial structures will also be provided.

BIOLOGY AND BEHAVIOR

Large flies are relatively short-lived insects that spend most of their time on four critical life activities: finding food and water, finding suitable breeding material, finding resting or wintering sites and reproduction. Understanding the biology and behavior of large flies, especially related to these critical life activities, is an important step towards identifying management and elimination strategies.

¹ Mallis, 2011 and AFPMB TG30, 2002

² Lamiaa et al., 2007; AFPMB TG30, 2002

Common Large Flies

Large flies have long been associated with humans, posing health threats in urban environments¹, military operations², medical facilities³ and many other environments⁴ where humans are found. They take advantage of many of our activities to find breeding sources, harborage, food and water.

House Fly



Musca domestica

Adults are 4-7 mm in length with four black stripes on the thorax. The sides of the abdomen are yellowish to cream colored with a broad dark band in the center.

Preferred breeding materials include feces, garbage waste and other decaying organic matter.

Bottle/Blow Fly



Various species in the family Calliphoridae

Adults are 4-16 mm in length with bodies up to twice as large as house flies. Their bodies often have a characteristic metallic color such as blue, green or black, reminiscent of shiny "bottles."

Preferred breeding materials include animal carcasses, feces and garbage.

Flesh Fly



Various species in the family Sarcophagidae

Adults are 4-22 mm in length with bodies up to three times as large as house flies. They have three characteristic black stripes going down the thorax. The abdomen is dull colored with a checkered pattern.

Preferred breeding materials include decaying meat, carrion, compost and garbage.

¹ Howard, 2001

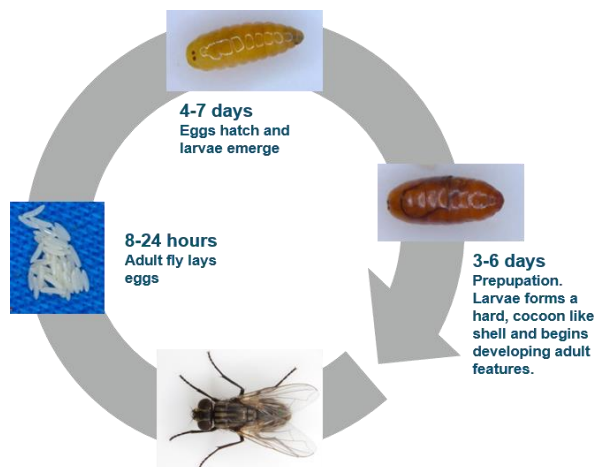
² AFPMB TG30, 2002

³ Fotedar, 1992

⁴ Keiding, 1976

Life Cycle

Large flies undergo complete metamorphosis, with four distinct life stages: egg, larva, pupa, and adult. The development time from egg to adult depends on the species, food availability, temperature and other factors, but under ideal conditions it can be less than ten days. Eggs are usually laid in batches on or near preferred food sources, although some flesh flies hold eggs inside their abdomens until after hatching, depositing live larvae. Larvae or maggots are headless and legless and spend their time wiggling through their semi-liquid food source. Just prior to pupation, maggots leave the breeding material and crawl to a nearby dry spot to pupate. In the pupal stage the developing adult fly is protected in a hardened case called a puparium. The puparium greatly reduces the effectiveness of many fly control measures and can result in adult flies continuing to emerge more than a week after control measures have been taken. Adult flies can travel over a mile from where they emerged in their search for suitable conditions for the next generation. The reproductive potential for large flies is tremendous with the potential of hundreds of thousands of flies being produced in a few weeks under the right conditions¹.



What attracts large flies to structures?

Large flies come to human structures both passively and actively. Passive fly pressure occurs when there are nearby locations that support large numbers of flies. This could include agricultural areas, garbage dumps and other prime fly-breeding locations. High pressure due to the passive presence of flies can be very difficult to address, especially when there are large numbers of flies spread over large areas. Reducing exterior pressure in some extreme situations may not be practical or even possible.

Large flies also actively fly to human structures. The following conditions may invite flies to structures as they search for food, water, suitable breeding sites and resting or wintering sites²:

- **Poor garbage handling practices** – not emptying garbage often enough can result in decaying organic material smells that attract large numbers of flies. Garbage spillage in and around receptacles can also pull flies close to a building.
- **Standing water** – Water accumulation that remains for long periods of time may attract flies, especially if organic material is also present.
- **Overgrown vegetation** – Overgrown grass and other plant material can provide fly harborage and possible breeding areas.
- **Attractive odors** – As large flies move from place to place they rely on a keen ability to find and follow attractive odors. Odors associated with decaying organic material will attract large flies as will some food production and processing odors. Fresh produce, bread and pastries, many beverages and even strong non-food smells can attract large flies. Understanding the odor profile of a structure can sometimes help in identifying solutions.

¹ Mallis, 2011

² Ecolab Field Observations

- **Visual attractants** – Large flies are attracted to different colored surfaces, light frequencies and physical forms depending on a variety of factors. Other attractants may include buildings, large openings into buildings and human activity.

House flies can travel large distances looking for suitable locations, with more than 15 miles recorded in some instances.¹ Once a food source is found, flies will remain in the area.² This results in flies congregating in areas where there are attractive odors or materials on which to feed. Once in an area, flies will congregate near food and breeding sources, on sunny sides of structures and where the temperature is optimal.

Why do large flies enter structures?

Large flies will enter structures in search of food, water and breeding opportunities. These pests actively enter doorways rather than drift or casually wander in. All doors are not created equal. When it comes to large fly access, the following factors play an important role³:

- **Number of flies near the door** – flies resting or flying near open doors will actively fly into these openings. Attractive odors in the immediate vicinity of doors bring flies close and may stimulate flies to explore inside the opening.
- **Open doors/windows** – how often and how long a door/window is open will directly impact fly entry. The time of day a door/window is open can also play an important role. Morning hours with warm temperatures can be peak times for large fly activity near doors/windows.
- **Movement of material through doors** – large flies also seem to actively follow people and other objects through doorways into structures.
- **Air pressure** – there are conflicting factors concerning relative air pressure inside and outside doors/windows. Negative air pressure inside the structure, if strong, may suck flies inside. Positive pressure inside, if strong, might help push flies out; however, positive pressure may also push attractant odors or attractant temperatures out and invite flies in. In general, neutral air pressure or a slight flow into the structure is preferred. The effect of air pressure differences at doors may be overcome with air curtains or simply keeping the door/window closed.
- **Resting or wintering sites** – Large flies are attracted by fresh and favorable sites to hide or rest during day or night and can enter in mass into a building to find a wintering site.

What is the most house fly-attractive odor in a quick serve restaurant?

Common food items from a fast food restaurant were presented to house flies to determine which odors were more attractive.

- French fries
- Fruit pies
- Chocolate shake
- Cooked meat patties
- Hamburger buns and condiments
- Cooked chicken strips
- Carbonated soda

Results – house flies in the study overwhelmingly preferred the cooked meat patties.

Application – The smell of cooking meat is a strong attractant to house flies. Where this odor exits the structure may determine how many flies get inside; if meat odor is found at doors flies may actively enter vs. another location such as roof venting.

- Ecolab Research, 2016

¹ Winpisinger, 2005

² Howard, 2001 and Nazni et al., 2005

³ Ecolab Field Observations

Open doors/windows are the primary culprit in the failure of a fly barrier. Open doors/windows are also a part of doing business. Finding ways to minimize open door/window time and looking for other ways to keep flies out even when open doors/windows are required is an important part of a successful large fly program.

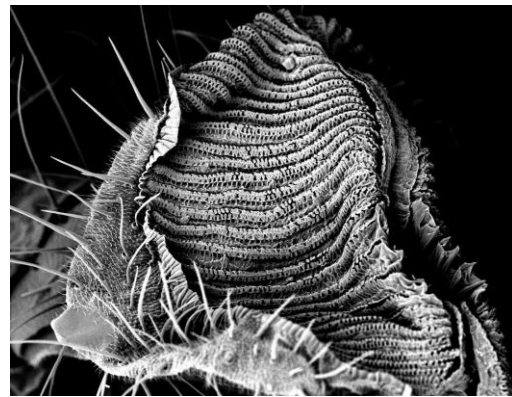
Why are large flies considered a threat to food safety?

Large flies have several troublesome behaviors that together make them a serious threat to food safety. A primary contributing factor is their affinity to both filthy and wholesome food¹.

Because large fly larvae develop in decaying material, a fly has spent part of its life in and on filth. Disease transmission can occur in several ways. First, the bodies of large flies are covered in hairs that passively pick up particles from the filth they visit. When a fly later lands on food or food handling surfaces, mechanical transfer of particles can occur². Similarly, the padded feet of large flies can collect filth from garbage, feces and decaying organic matter that can then be transferred onto other surfaces on which they land. Large fly mouthparts are also capable of transmitting filth and disease to clean surfaces. Because adult filth flies can only feed on a liquid diet and cannot chew food, they will often deposit saliva and vomit containing enzymes that help liquefy a solid food source. This unique feeding behavior can result in the transfer of millions of bacteria and other disease-causing organisms onto food and food handling surfaces.



Large Fly Tarsus or Foot showing the tiny hairs that help it cling to surfaces and that can pick up microorganisms from surfaces they land on.



Large Fly sponging mouthparts with grooves and folds used to spread saliva and mop up food.

¹ Butler, 2010

² De Jesus, 2004

LARGE FLY MANAGEMENT STRATEGIES

Addressing large fly activity is best done through an Outside-In Approach. Identifying root causes and finding solutions to suppress fly activity before they enter a structure will bring the best success. The Outside-In Approach can be organized into three layers of protection:

1. **Exterior** – reduce large fly pressure on the outside
2. **Barrier** – minimize large fly entry into the structure
3. **Interior** – rapidly remove large flies from within the structure

1. *Exterior - Reduce Large Fly Pressure*

Reducing large fly pressure on the exterior of a structure can be accomplished through an Integrated Pest Management (IPM) strategy. A combination of approaches is often required and could include some of the following:

- **Eliminate breeding sources** – The presence of maggots indicates a serious lapse in sanitation that must be corrected. Large fly breeding near a structure will result in extremely high fly pressure and likely result in large numbers of flies inside. Breeding material is better removed than treated. Large fly breeding can occur in spilled garbage outside and inside receptacles including dumpsters and compactors. Breeding can also occur hidden inside garbage bags if they are not removed at least weekly¹.
- **Minimize fly-attractive odors** – There are many odors that attract large flies. A careful odor survey in high pressure situations may lead to the discovery of simple corrective actions that reduce flies in the area or that moves flies away from vulnerable entrance points.
- **Minimize other attractants** – Other attractants include overgrown vegetation, standing water, old equipment and other fly friendly habitats. A regular inspection of the exterior to identify and remove these attractants is a good practice.
- **Pesticide application** – The targeted use of pesticides can also reduce pressure on the exterior. Proactive or preventative applications to known or typical exterior fly resting and staging sites can greatly reduce large fly activity in the area. Care must be taken to make sure applications are made according to the product label. It is recommended that a professional pest management provider evaluate and properly apply pesticides.

Reducing large flies on the exterior should always be the first option considered. If the exterior pressure issue can be solved, then the other two layers of protection become precautionary.

2. *Barrier - Minimize Large Fly Entry Opportunities*

A large fly barrier is the second level of defense. This is the last opportunity to stop a fly before becoming a food safety hazard inside the structure.

- **Close the door/window** – Look for ways to minimize open door/window time. Changing the time of day doors/windows are left open for extended periods may help reduce interior large fly activity.
- **Add additional barrier protection** – If doors/windows must remain open, exploring additional barrier options is warranted in high pressure locations. Screens, air curtains, plastic strips, vestibules and other added protection should be considered.

¹ Ikeda, 1972

3. Interior – Rapidly Remove Large Flies

Once a large fly has entered the structure, rapid removal becomes critical. Every minute a large fly is free to move about the interior is another minute of risk.

- **Reduce exterior pressure and fix the barrier** – Large flies inside should immediately raise the question, “Can we further reduce pressure on the structure and create a better barrier?”
- **Pesticide applications** – The targeted use of pesticides on the interior can quickly remove flies if applied to common large fly resting spots. Care must be taken to make sure applications are according to the product label. It is recommended that a professional pest management provider evaluate the use of and proper application of pesticides. Consumer bug sprays and aerosol cans of fly spray purchased from retail stores should not be used. Often, these consumer products are not labelled for indoor use in, and cannot be stored in, commercial facilities. If an aerosol fly spray is needed, consult with, and purchase product from your pest management provider.
- **Insect light traps** – Large flies are attracted to UV light traps. Placements of light traps near fly entrance points and in areas where flies congregate can help reduce fly numbers on the interior. There has been much research done on light trap effectiveness and efficiency. Despite advances in this field, light traps are still a last line of defense, and many flies caught on interior traps does not indicate a successful large fly program.

SUMMARY AND CALL TO ACTION

Large flies are a common pest and closely associated with human activities. Beyond being an annoyance, large flies can also serve as mechanical vectors of disease and are a serious threat to food safety. Solving large fly issues is best done with an Outside-In Approach using IPM practices based on fly behavior. There are also many day-to-day things that can be done to reduce the presence of flies around your facility.

What You Can Do

- A. Reduce fly pressure outside of structures
 - Eliminate spillage of garbage.
 - Close all garbage receptacles with tight-fitting covers and ensure garbage is removed weekly or more often if possible.
 - Move garbage receptacles away from the facility whenever possible.
 - Eliminate standing water around the facility.
 - Remove weeds, tall grass and other excessive vegetation.
 - Remove clutter and items stored on the ground near the facility.
 - Consider other sources of large fly pressure from nearby locations and work with neighbors and the community to reduce fly activity in the area.

- B.** Minimize fly entry opportunities
 - Seal all doors, inspect and repair entrances on a regular basis.
 - In high pressure situations consider screens, double-door vestibules, air doors and plastic strip doors.
 - Minimize the amount of time doors and windows are left open.
- C.** Minimize conditions that support fly activity on the inside of the structure
 - Eliminate standing water and accumulated condensation.
 - Limit interior access where possible by keeping doors to back areas closed.
 - Clean food debris thoroughly and regularly.

What Ecolab Will Do

- ▲ Provide a science-based, risk assessment approach to monitor and address large fly activity in and around your business.
- ▲ Provide regular, visual inspections of the outside and inside of structures by trained professionals.
- ▲ Document sanitation and structural issues that are conducive to fly activity and may lead to interior large fly presence.
- ▲ Meet with management and make recommendations on improving conditions to reduce fly activity inside.
- ▲ Provide the most effective equipment in the industry.
- ▲ Apply pesticide only as needed to targeted areas, reducing the risk of exposure.

For more information, contact Ecolab Pest Elimination 800-325-1671 or pest@ecolab.com

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Douglas Gardner provides over 20 years of industry experience and 9 years of academic research to the Ecolab Pest Elimination team. His background as a biologist includes a B.S. degree in biochemistry from the University of Arizona and an M.S in Entomology from Texas Tech University. He has received the designation as a Board Certified Entomologist from the Entomological Society of America and as a Registered Sanitarian from the National Environmental Health Association. He has held a variety of positions in his professional career from providing pest services as a service specialist to leading teams of experts in operations, technical support and research. Research focusing on large flies and rodents has been his passion although he has a broad understanding of the science of pest elimination. Douglas is currently a corporate scientist providing expertise and driving innovation for Ecolab Pest Elimination.

ECOLAB PROPRIETARY

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