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

National Fruit Fly Detection Trapping Guidelines

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When using pesticides, read and follow all label instructions.

This list is **not** intended to be all inclusive and is intended to be a reference guide solely for convenience of potential users. **No** endorsement is intended of the particular items listed, and **no** discrimination is intended toward those products or companies that may **not** be listed.

Product manufacturer names and addresses are subject to change without notice. PPQ does **not** regularly verify the accuracy of the information.

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Chapter 1

Introduction

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Background

Fruit flies in the family Tephritidae are among the most destructive, feared, and well-publicized pests of fruits and vegetables around the world. The genera *Anastrepha*, *Bactrocera*, *Ceratitis*, *Rhagoletis*, and *Zeugodacus* pose the greatest risk to U.S. agriculture and are the focus of this manual. Tephritid fruit flies spend their larval stages feeding and growing in over 400 host plants. Introduction of these pest species into the United States causes economic losses from destruction and spoiling of host commodities by larvae, costs associated with implementing control measures, and loss of market share due to restrictions on shipment of host commodities. The extensive damage and wide host range of tephritid fruit flies become obstacles to agricultural diversification and trade when pest fruit fly species become established.

Purpose

The purpose of this manual is to improve and standardize decision making, training, and quality control for exotic fruit fly detection surveys.

This manual represents the currently accepted procedures for exotic fruit fly detection and includes well documented analyses, observations, and feedback from individuals with extensive experience in survey and control of exotic fruit fly infestations. It represents the minimum recommended trapping survey levels that should be conducted for the species listed.

This manual was drafted by a committee of State and Federal employees of plant protection and regulatory agencies and revised by the National Fruit Fly Trapping Committee. They utilized existing State fruit fly program protocols, publications, and their own experience to assemble a set of guidelines, which give flexibility, reliability, and economy for conducting exotic fruit fly detection surveys.

Following the detection of an exotic fruit fly, program staff will develop a delimiting survey program to determine the boundary of the population. Delimitation surveys increase the density of traps and sometimes the types of traps. Delimitation trapping guidance is **not** part of this manual.

This manual includes procedures for baiting, placing, and servicing traps. It does **not** provide guidance on interpreting captures of exotic fruit flies and does **not** define triggers that should be used when deciding whether to initiate an emergency response or eradication program (for definition of triggers refer to the USDA APHIS Cooperative Fruit Fly Emergency Response Triggers & Quarantine document. Nor does it provide guidance on issues that may vary locally, such as methods for disposing of trapping waste. For additional information regarding exotic fruit fly detection, control, and quarantine please contact your State Plant Health Director or your State Plant Regulatory Official. You may also visit the APHIS Pest and Disease Programs Fruit Flies website.

Users

The manual will be used by the following:

- Managers, to plan and budget surveillance activities within their jurisdictions
- Supervisors, to train, instruct, and provide standards for their employees
- Trappers, as daily checklists and operational guides
- All other employees involved in exotic fruit fly surveillance, to explain the nature of survey activities to the general public

Program Roles and Responsibilities

Public Relations

All employees should have a good understanding of the importance of public support for the program and how it affects efficiency and success of fruit fly detection. The following guidelines apply to all employees:

- Be considerate of people and their property
- Display courtesy at all times
- Display safe and courteous driving habits
- Know the goals and purposes of the program and the reasons for the procedures and be able to explain it to the public using clear, simple language
- Maintain a good public image
- Follow agency dress code policies
- Wear identification badge
- Contact homeowners for property access and explain the purpose of the trapping activities before trap placement
- Provide written program information, such as a door hanger with local program phone number or contact business card, if available

Safety

All employees **must** be familiar with and follow all applicable safety protocols and any additional safety precautions set forth in these trapping guidelines. The following list, which is **not all inclusive**, notes some required procedures:

- Use caution when entering a property to avoid dog bites and other avoidable injuries, such as damage to the eye by tree limbs, slip, trips and falls.
- When servicing traps at the vehicle, always work on the passenger side or back of vehicle away from road traffic.
- Wear and maintain proper personal protective equipment (PPE) when handling lures and pesticides. This includes using disposable latex gloves at least 5 mil in thickness.
- Clean or dispose of PPE as soon as they become contaminated.

All employees are required to know and follow the agency vehicle guidelines. As a rule, when using a government vehicle:

- Use safe driving practices.
- Know what to do in case of an accident.
- Keep the vehicle clean, operating properly, and maintain mandatory vehicle logs.
- Comply with agency provided defensive driving training.
- Know that abuse of a government vehicle can lead to disciplinary action or dismissal.

PPQ Cross-Functional Working Group (CFWG)

The cross-functional working group (CFWG) oversees the domestic portion of the APHIS Fruit Fly Exclusion and Detection Program. The CFWG has the following responsibilities:

- Develop annual program plan and budget
- Monitor and track allocations and obligations
- Develop recommendations and approve appropriate changes for program execution
- The CFWG is composed of the National Policy Manager, National Operations Manager, National Program Science Coordinator. Additional support staff may include an Assistant National Policy Manager and Biological Science Technician(s)

PPQ Emergency and Domestic Programs (EDP)

The Policy Manager has the following responsibilities:

- Assures overall consistent implementation of fruit fly detection procedures and implements trapping policy updates to detection strategies and technology when they become available.
- Ensures that a quality assurance component is in place for detection tools and quality assurance of the overall program implementation.
- Assures that, nationally, fruit fly detection trapping networks are viable and that resources are applied appropriately; keeps the national fly detection records up to date.
- Requests appropriate reviews of all trapping networks or grids, to ensure adequate trap arrays and density.
- Works closely with trade officials to assure that correct protocols are being utilized and that these are communicated appropriately to trading partners.

PPQ Field Operations (FO)

Field Operations are responsible for the following:

- Assures that operations are at the highest level of effectiveness and efficiency,
- Applies the appropriate resources as required.
- Conducts periodic program evaluations in the field on program effectiveness.
- Implements recommendations on new program tools nationally based on standard protocols and approved detection guidelines.
- Provides guidance to the field on survey supply inventory and purchases.

PPQ Science and Technology (S&T)

The program methods development component (S&T) has the following responsibilities:

- Conducts field trials to assure trap and lure contract performance and quality assurance
- Develops and evaluates fruit fly detection tools and strategies for program improvement, including new traps and lures and new operational methods
- Makes recommendations to fruit fly program managers on detection improvements

State Government

State cooperators are major partners in the National Fruit Fly Exclusion and Detection Program. Each State may have its own detection program guidelines and Action Plans. These State-level documents may have more detail than this manual and may be more fine-tuned to account for unique local conditions. State cooperators work closely with Federal counterparts in states conducting fruit fly surveys.

Responsibilities of State cooperators may include:

- Coordinate statewide fruit fly trapping programs for detection of exotic fruit flies
- Liaise with stakeholders and agricultural industries as their primary contact
- Lead emergency response and eradication activities

Supervisors

Supervisors are responsible for all work being performed properly including:

1. **Orientation**- supervisors should ensure that all employees are given thorough program training that provides an understanding of the following information:
    A. Safety
    B. Basic biology and identification of target pests
    C. Identification of fruit fly hosts
    D. Knowledge of the traps and lures, proper trap placement, and servicing schedules
    E. Data management
    F. Quality assurance system in place
    G. Pathways of potential introductions into the United States
    H. Understanding and implications of regulatory actions
    I. Economic impact of target pest introductions
2. **Quality Assurance**- Supervisors should regularly evaluate work performance by accompanying employees on their normal route and perform periodic unscheduled checks on employees' work. This may include the use of dyed QA fly specimens placed in traps. It is important to document and explain to the employee how their work can be improved as well as what they are doing well.
3. **Safety**- It is the supervisor's responsibility to instruct employees in the safe use and operation of all supplies and equipment, including vehicles. Supervisors should perform the following:

A. Conduct background checks for driving offenses and licensing and ensure employees maintain agency provided defensive driving training certification
B. Check that vehicles are operated safely and maintained in a safe condition
C. Ensure that trappers are aware of and adhere to pesticide safety regulations and requirements, including relevant safety data sheets (SDS) and the use of PPE
D. Identify common hazards in residential and commercial settings
E. Check periodically to ensure that employees are performing their functions safely
F. Provide a list of emergency medical treatment centers to employees

Trappers

Trappers are responsible for the following:

- Be respectful and courteous when dealing with the public
- Seek permission to access private property and leave flyers (door hangers)
- Be able to identify target insects and report suspect finds to supervisors
- Know and follow proper procedures for handling, documenting, and submission of specimens for identification
- Recognize host plants and know the relative host preference of target pests
- Place and service traps according to trapping protocol
- Avoid contamination of traps and environs
- Perform required trap relocations
- Run trap line with efficient route order and complete servicing route on schedule
- Know and follow information in trapping manual
- Maintain proper trap densities and distribution
- Maintain trap records with accurate map drawings, trap locations, and hosts
- Note possible hazards in the comment section of the property survey record
- Keep trap distribution maps current with accurate trap locations using GPS coordinates
- Maintain legible and timely service records as required
- Remove all traps from the field at the end of the trapping season, if applicable
- Properly dispose of trash, used traps, and components in program approved receptacle
- Keep accurate vehicle records
- Maintain equipment and supplies
- Quickly implement new policies and procedures

Use proper chain of command, as directed by supervisor

Advisories

Advisories are used throughout this manual to bring important information to your attention. Carefully review each advisory. The definitions coincide with the American National Standards

Institute (ANSI), with the goal of making the warnings easy to recognize and understand[1] and are in the format shown below.

⚠ DANGER

Example of the Danger message table. The Danger message is used in the event of imminent risk of death or serious injury.

⚠ WARNING

Example of the Warning message table. The Warning message is used in the event of possible risk of serious injury.

⚠ CAUTION

Example of the Caution message table. The Caution message is used for tasks involving minor to moderate risk of injury.

NOTICE

Example of the Notice message table. The Notice message is used to alert a reader of important information or Agency policy.

SAFETY

Example of the Safety message table. The Safety message is used for general instructions or reminders related to safety.

How to Find More Information

Contact the State Plant Health Director in the State or the National Policy Manager for fruit flies (refer to the "Program Contact Information" section on the APHIS Pest and Disease Programs Fruit Flies for National Policy Manager contact information.

National Fruit Fly Trapping Guidelines Contacts

Information Services and Manuals Unit (ISMU)

The PPQ Information Services and Manuals Unit (ISMU) issues and maintains manuals electronically on the APHIS Plant Protection and Quarantine Manuals webpage.

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

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

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

PPQ Import Services Customer Support

If information regarding a policy, procedure, or commodity admissibility appears incorrectly in the *National Fruit Fly Trappings Guidelines*, contact PPQ Import Services Customer Support at 301-851-2046 or 1-877-770-5990 with an explanation and recommended correction.

National Fruit Fly Trappings Guidelines Liaison

If you have an urgent situation requiring a response regarding the *National Fruit Fly Trappings Guidelines,* contact the program specific liaison, Catherine Marzolf, by email at catherine.a.marzolf@usda.gov.

Chapter 2

Trapping Procedures

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Trapping Equipment

List 2-1 Equipment Useful in the Placement and Servicing of Traps

- Alcohol (70%) for specimen storage
- Buckets with lids
- Decontaminant solution
- Flagging tape
- Flat pan
- First aid kit in vehicle
- Forceps
- Funnel
- Garbage bags for used traps wicks and other trash
- Hand cleaner and paper towels
- Hand lens
- Labels for specimen submittal
- Measuring cup
- Mobile device (iPad)
- Pencils and erasers
- Permanent marker

- PPE
- Public outreach material (e.g., door hanger)
- Safety cone
- Safety Data Sheets (SDS)
- Scrub brushes
- Sip-top bags for trap inserts with specimens
- Spray bottles
- Strainers
- Trap bodies and lures, capture liquid (e.g., 10% propylene glycol)
- Trap book with property maps/records
- Trap stick for hanging traps
- Trapping guidelines
- Vials for specimens
- Water
- Wax pencils for writing on trap body

Trapping Season

Some areas are trapped year-round and other areas are trapped on a seasonal basis, depending on seasonal temperature variation, detection history, seasonal fruiting of host plants, and pathway analysis of the target species of interest. Decisions to trap seasonally should be made collaboratively between PPQ and State fruit fly staff. Final decisions related to seasonal trapping, including the technical, political, operational, or economic justification for the decision, should be recorded in writing, communicated to stakeholders, and stored according to records management policies.

Trap Densities

The density of traps in an area influences the ability to detect invasive fruit fly populations: the higher the density of traps, the higher the likelihood of making an early detection.

Several factors can be considered on the ground when deciding on appropriate trap density including:

- Availability of suitable hosts
- Trap/lure efficiency
- Climate factors conducive to the pest, including local climate factors such as temperature, altitude, and topography
- Other program complementary activities, such as a Preventive Release Program (PRP)
- Evidence of potential pest pathways to a local area, such as:
    - Densely populated areas
    - Historical detections from trapping records
    - Major ports of entry (land, sea, air)
    - Wholesale fruit and vegetable marketing centers and street vendors (i.e., high availability and demand for exotic fruits and vegetables)
    - Gardening groups and clubs specializing in rare fruit propagation

We divide the landscape into four categories (high, medium, low, and marginal) based on the likelihood that fruit flies will be introduced there. For areas that are expected to be at equal risk of invasion by all fruit fly species (e.g., areas that are distant from international borders, have high human population density, and are hubs for international travel), all trap lure combinations should be placed at similar density within that area. For example, an area categorized as "high likelihood of introduction" for all fruit fly species, should include trap lure combinations for all target genera and species (refer to Descriptions of Traps and Lures) at the high trapping density described below.

Some areas have higher likelihood of introduction for certain species over others (e.g., areas close to the Mexican border have higher likelihood of introduction of *Anastrepha* spp. via overland pathways or natural migration than areas distant from the Mexican border). Therefore, areas may be considered "high likelihood of introduction" for some species but **not** others, and the trapping density of the specific trap lure combinations (refer to Descriptions of Traps and Lures)) should reflect this variable likelihood.

Recommended trap densities are based on guidelines from the International Atomic Energy Agency (IAEA), Federal, and State protocols. Survey areas should be risk assessed to determine the appropriate trap density. Check with APHIS or State fruit fly program managers on what is appropriate based on funding and likelihood of introduction.

The following guidelines are the requirements for trap densities:

- **High Likelihood of Introduction (ports of entry; urban or suburban areas with a history of frequent detections):** Minimum of 10 traps per square mile
- **Medium Likelihood of Introduction (urban or suburban areas without a history of frequent detections):** Minimum of 5 traps per square mile
- **Low Likelihood of Introduction (rural areas):** Minimum of 1 trap per square mile
- **Marginal Likelihood of Introduction (marginal environment suitability):** Minimum trap density of 1 trap per 5 to 10 square miles (relocated between square mile sections)

Trap Placement

Site and Host Selection

Select based on the following criteria:

- Upon homeowners' approval, utilize best host at that site.
- If there is a choice between two or more possible trap locations, preference should be given to the site with multiple hosts either of the same or different varieties.
- Consider amount of shade and shelter. Particularly in hot weather, select sites that provide shade or roosting sites for fruit flies.
- If host tree is too small for proper trap placement, place trap in a nearby nonhost tree that provides proper height and shade.
- Place traps out of reach of people and animals.

- Do **not** hang traps in trees that show signs of decline due to disease or age.
- Trees in bloom or with fruit are preferred.

Placement within Tree

Traps should be placed in the upper two-thirds of the tree canopy on a strong branch and one-half to two-thirds the distance from the trunk to the outer edge of the foliage.

Hang traps within the tree canopy in open shade. **Do not place the trap in dense foliage that may block the entrance to the trap.** During extremely hot weather, traps should be hung in shadiest areas of the tree.

Hang traps out of reach of people and animals. Before placing the trap in a tree, consider security of the trap, as well as the safety of children and animals.

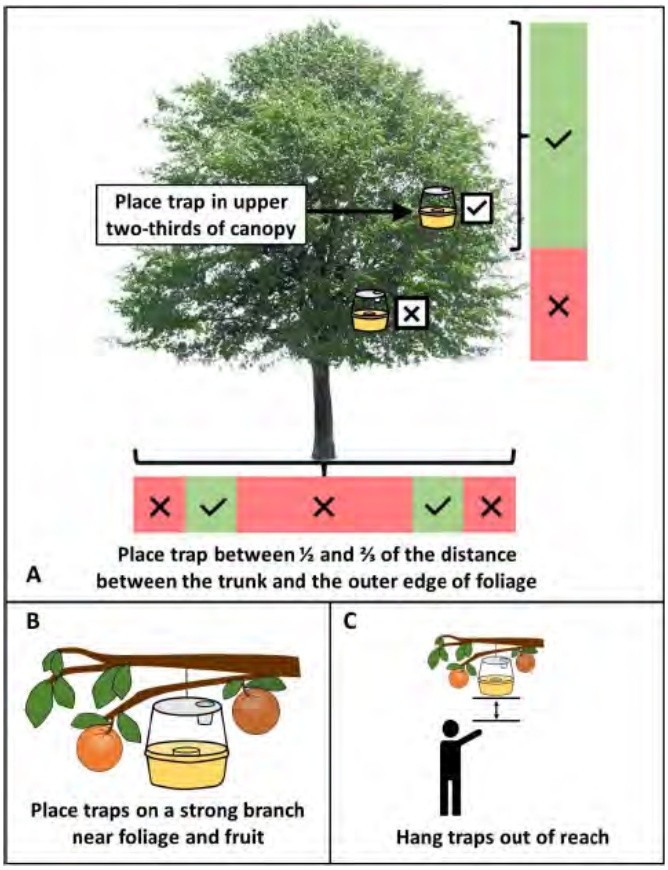

Figure 2-1 Trap Placement within a Tree

Trap Relocation

Relocation can compensate, at least partially, for a lure's limited range of attraction, and it provides trappers with an opportunity to adjust trap sites for seasonal changes in host phenology.

A trapping scheme should distribute traps among host material. Traps should be relocated on a quarterly basis (~12 weeks) or based on host phenology. The minimum distance that a trap is

moved at any given relocation is dependent in part on trap density. At each relocation, traps should be placed according to the State or National trap placement guidelines (e.g., preferentially use hosts that are fruiting).

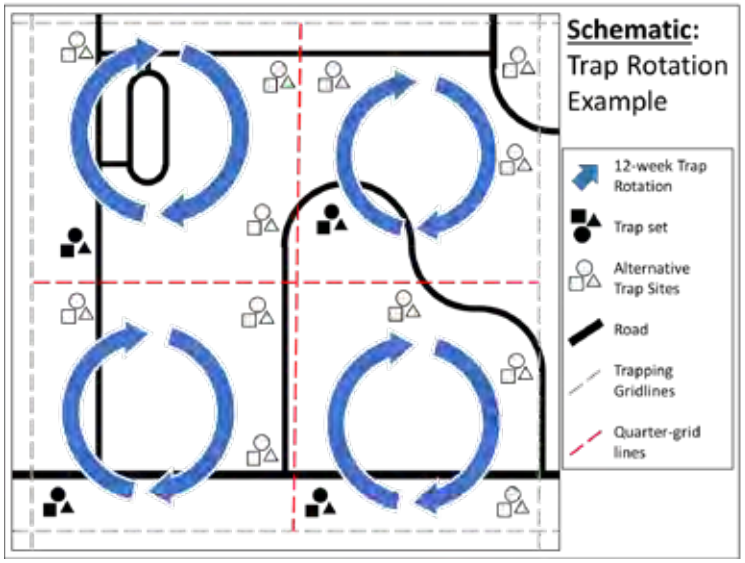

Figure 2-2 Trap Rotation Example

Specimen Management

Maintaining specimen integrity and chain of custody ensures detections are properly cataloged, identified, and stored for further analysis. Any trap with suspect flies should be handled carefully. Trappers **must** collect and submit any suspect flies for identification following the State or National program guidelines.

Data Management

Detailed trapping data **must** be effectively organized and maintained to ensure consistency, accuracy, and uniformity in survey methodology. This information is generally kept on a Property Survey Record, and it provides recorded information regarding the exact location of the trap, servicing, relocation, baiting, and detection history.

Individual States may have their own form, but all trap records should include the following information:

- Records of trap servicing, baiting, relocations, including dates, trapper's name, specimen submission to lab
- An identification number for each trap
    - The exact location of each trap including:
    - County
    - City

- Mapped location on property
- GPS coordinates
- Host
- Address

Trap books, maps, records, specimen submission data, etc., **must** be accurate. Legible maps of trapping grids depicting the distribution of traps **must** be kept.

When recording trap information give close attention to the following details:

- Date
- Street / address
- City and county
- Section, Township, Range (STR), if applicable
- GPS coordinates of each trap (latitude and longitude)
- Trap/lure type
- Category for likelihood of introduction (high, medium, low, or marginal)
- Survey type (e.g., routine (year-round), seasonal, emergency delimitation, if area is under sterile insect release, Preventive Release Program (PRP))
- Trap book name (trapline)—typically a day's work
- Trap location notes on property with abbreviations (L = left, R = right, F = front, RDSD = roadside, etc.)
- Trapper's name
- Always use pencil for trap card entries
- Draw property diagram maps with "north" toward the top border. Indicate north on each map with an "N"
- Label the street name where the trap is placed, as well as at least one close cross street. Always denote "street", "drive", "avenue", etc. (Use the standardized address format in your program)
- Name the host type (e.g., orange) and mark its approximate location on the property
- If necessary, include a written description of the location of the traps on the property in the comment section on the property records. A more detailed description will be needed for those locations that are **not** easily found.
- Sketch recognizable structures on the property where the trap is placed.
- Update records in trap book and database immediately after servicing, baiting, relocating or changing host in the field. Do **not** wait until a later time to record data
- **Never** run a trap line without the trap book / property records.
- Sketch recognizable landmark structures and distances when an address is **not** available.
- Utilize an approved database system (eTRAP or Field Maps) for management of fruit fly records.

NOTICE

Paper data records are public records and should be retained for at least 5 years. Digital records should be retained in accordance with government public records policy.

Quality Assurance

Quality assurance (QA) is a systematic effort to maintain the performance and accountability of the trapper and trapping program. Regularly conducted (i.e., quarterly) quality assurance testing should evaluate adherence to trapping standards and note possible areas for improvement. This ensures that trapping data maintain a consistently high quality and that new incursions will be detected quickly. This also assures standardization across the program. QA requirements may be mandated by the State or National fruit fly program.

Quality assurance should be conducted as follows:

- A quality assurance person (supervisor or designee) periodically rides with the trapper and indicates where improvements can be made.
- A quality assurance person takes the trap book and services the trap line by themselves to evaluate the comprehensiveness of trap book entries. Any suggestions for improvement should be noted. Be specific.
- Fluorescent dyed sterile fruit flies can be placed in traps for QA purposes. This targeted placement of QA flies in traps assures accountability of the trapper and can also provide valuable information regarding how a specimen moves through the system from detection to identification to response. **All supervisors and trappers in the program must be aware that this method of quality assurance is to be used.**
- Among other parameters, the following should be regularly monitored and evaluated:
    - Mapping—maintain current GPS coordinates and maps
    - Trap condition and placement
    - Trap servicing/baiting
    - Site selection
    - Host selection
    - Trap distribution
    - Trap density
    - Updated category for likelihood of introduction
    - Trap relocations
    - Equipment and safety
    - Recordkeeping—trap book and electronic database

Chapter 3

Descriptions of Traps and Lures

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Trap and Lure Combinations

Four main traps are used to trap different fruit fly species across the domestic fruit fly program. Research has identified the most attractive trap and lure combinations available for each fly species. Therefore, it's important to pair the correct trap with its corresponding lure for optimal attraction. The food-based attractants are attractive to a variety of species, but **not** all species are equally attracted to every lure. Refer to Figure 3-1 for descriptions of recommended trap-lure combinations for each species.

	Trap	Lure	Target fly
Male Biased Lures (male-specific attractants)	 Jackson trap	Trimedlure	*Ceratitis* spp.
		Cuelure	*Bactrocera tryoni* *Bactrocera frauenfeldi* *Zeugodacus cucurbitae* Additional *Bactrocera* and *Zeugodacus* spp.
		Methyl eugenol	*Bactrocera dorsalis* *Bactrocera correcta* *Bactrocera zonata* Additional *Bactrocera* spp.
Female Biased Lures (food-based lures)	 McPhail trap	Torula yeast and borax	*Anastrepha ludens* *Anastrepha suspensa* *Anastrepha* spp. *Bactrocera* spp. *Ceratitis capitata* *Zeugodacus* spp.
	 Multi-Lure trap	Torula yeast and borax	Same as torula yeast in McPhail traps above
		Two-component lure (putrescine and ammonium acetate)	*Anastrepha ludens* *Anastrepha suspensa* *Anastrepha* spp.
		Three-component lure (putrescine, ammonium acetate, and trimethylamine)	*Ceratitis capitata* *Ceratitis* spp.
	 Yellow Card trap	Ammonium acetate	*Rhagoletis cerasi* *Rhagoletis* spp.

Figure 3-1 Trap-Lure Combination Recommendations

McPhail Trap

The McPhail trap is made of heavy glass and consists of a water reservoir containing dissolved attractant compounds. Flies enter from below through the opening and drown in the solution. The trap has a rubber cork that seals the top of the trap and a wire hanger. McPhail traps are paired with proteinaceous liquid attractants dissolved in water, like torula yeast or Nu-Lure®.

Figure 3-2 McPhail Trap

Attractants for McPhail Trap: Proteinaceous Baits

Proteinaceous baits or natural food baits are used in McPhail Traps.

Torula yeast comes in 5 gram pellets and includes borax, a preservative. These pellets are dissolved in water to produce an attractant slurry.

Capture agent for McPhail Trap: Water-based Slurry

Water is used as the capture agent in McPhail traps. Flies are attracted by the dissolved torula yeast and drown. Antifreeze can be mixed in the water at low concentration for enhanced fly preservation.

Servicing and Baiting McPhail Traps with Torula Yeast Borax Pellets

Add water to a level just below the inside lip so that minor tilting will **not** cause spillage. This is important since solution residue on the outside glass surface will leave a protein deposit that will discourage flies from entering the trap and drowning in the solution. Place torula yeast pellets into water at a ratio of 1 pellet per every 100 ml of water (3 to 5 pellets per trap, 300 to 500 ml slurry per trap) and stir. This ratio produces a slurry that is attractive to fruit flies (normally **not** too thick or too thin).

Service and replace the bait weekly due to high nontarget insect captures and other contamination. When possible, the torula yeast slurry should be allowed to ferment for 3 days prior to initial servicing or placement. Premix the slurry in a large container and stir it on occasion for 3 days before filling traps and placing in the field.

Follow these steps to service the McPhail trap:

- Using a trap stick, remove the trap from the tree, keeping it upright to avoid spillage and take the trap back to your vehicle.
- Gently swirl the liquid to immobilize any specimens. Remove the stopper and pour the contents of the trap through a strainer placed over a 5-gallon bucket used for this purpose. Additional water **must** be added to the trap and swirled to remove all specimens.
- **Float all captures.** Dump the contents from the strainer into the shallow, white plastic float pan filled with clean water and examine the contents. If many flies or a lot of debris is present, contents of trap may have to be strained and floated **more than** once in order to view all specimens properly. A single layer of floating specimens will allow optimum examination. Note: softened and rolled wings, even if detached from fly bodies, will straighten out and be readily seen on the surface of the water.
- Remove any fruit flies or other insects of potential interest from the strainer and place them into a vial with 70% alcohol. The alcohol preserves the specimens.
- Label the vial with trap location, trap type, date, and any other pertinent program information, and return the vial to the local supervisor or other designated person for screening and identification.
- Avoid spilling bait since flies might be attracted to the material instead of entering traps.
- Clean contaminated traps before use. Transparency of the glass is important to attracting flies into the trap.
- Use suitable container (5-gallon bucket with lid) to dispose properly of old bait and wash water.

Table 3-1 Example of Servicing and Rebaiting Interval*

McPhail Trap						
Day 0	Service and rebait once a week					
Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42

*Terminology: Service = check for and remove all trapped flies and debris; Rebait = replace bait and capture liquid.

McPhail Trap Cleaning

McPhail traps should be cleaned **at every servicing**. It is recommended to carry a clean, baited trap to the tree and return to the vehicle with the old trap. After the contents of the trap have been screened, place the trap in a bucket of soapy water and/or recommended disinfectant so that it can soak until you arrive at the next site. Wash McPhail trap out with a mixture of 1 to 2 tbsp

Dawn dish soap (or similar detergent) and 5 gallons of clean water. For messier traps, toilet bowl cleaner can be used.

Do not use any abrasive cleaner or cleaning implement; this will scratch and damage the trap, and repeated abrasive cleaning will cloud the trap.

Common Target Flies and Corresponding Lures for McPhail Trap

Table 3-2 McPhail Trap Target Flies and Corresponding Lure

Target fly:	Lure:
Anastrepha ludens	Torula yeast and borax dissolved in water
Anastrepha suspensa	
Anastrepha spp.	
Bactrocera spp.	
Ceratitis capitata	
Zeugodacus spp.	

Multilure Trap

Multilure traps are a plastic version of McPhail traps with an opening in the bottom that permits entry of flies. The bottom reservoir is filled with capture liquid. Flies that enter the trap fall into the liquid and drown. Multilure traps are used with proteinaceous baits, like the McPhail traps, including synthetic food baits.

The most common type of Multilure trap includes a well in the lid for holding a lure. In addition, clips are available in the lid for holding sticky panels or hanging lures.

Figure 3-3 Multilure Trap

Attractants for Multilure Trap: Synthetic Food Lures

Patches or cone synthetic food lures are used in Multilure traps. They come in two variants:

- 2-Component lure (2C) - putrescine and ammonium acetate
- 3-Component lure (3C) - putrescine, ammonium acetate, and trimethylamine

Capture Agents: Propylene Glycol - Preferred

Use propylene glycol (PG) solution with 3C, 2C, or proteinaceous lures in Multilure traps. A 10% solution of PG or similar low-toxicity antifreeze diluted in water has several advantages over borax. PG appears to preserve flies better than the borax, slows evaporation, and may even enhance the attractiveness of the lures. The PG solution **must** be replaced every 6 weeks when baiting or topped off sooner if evaporation occurs.

Servicing and Baiting Multilure Traps

Service traps (i.e., inspect the traps for captured flies) every 1 to 3 weeks depending on risk and season. Top off capture fluid, if needed, when servicing traps. Follow servicing instructions for McPhail traps.

Baiting intervals may need to be adjusted to local climate and temporal conditions. Replace the lures and the capture liquid at the same visit. In addition, check the capture liquid at every inspection, topping up any evaporated or spilled liquid.

Baiting Multilure traps with cones

Never service a wet trap while it is still hanging in the tree.

- Remove the yellow cap from the bait well in the clear plastic upper-half of the Multilure trap.
- Open the polyseal foil bag that contains the cone. The cone has a red plastic cap on one end.
- Place the cone into the bait well, using the packaging, gloves, or forceps to avoid touching the cone. Position the red plastic cap in first to prevent the bait from sticking to the bottom of the bait well.
- Once the cone is in the well, replace the yellow lure cap on the bait well.
- Add fresh capture liquid to trap. The trap reservoir should be maintained with ~400 ml of capture liquid solution. When baiting, collect the used capture liquid for recycling. Refer to your supervisor for recycling procedure. Capture liquid should be recycled separate from any other additives or chemicals.
- Once the cone and capture liquid has been added, attach a hanger to the trap and position where needed.

Figure 3-4 Multilure Trap with Cones

Table 3-3 Example of Servicing and Rebaiting Interval*

Multilure Trap						
		Service		Service		Service & Re-bait
Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42

*Terminology: Service = check for and remove all trapped flies and debris, top up capture liquid if necessary; Re-bait = replace lure and capture liquid.

⚠ CAUTION

All lure components can be irritating to eyes, skin, and the upper respiratory system.

- Bait traps outdoors or in a well-ventilated area.
- It is recommended to use gloves or tweezers whenever handling bait.
- Lure components should be stored in a cool, well-ventilated area.
- Do **not** burn or store near flames. Evacuate the area in case of fire in storage area.
- Do **not** open bait packages inside offices or vehicles, and do **not** store used traps in offices as they retain the bait odor! Used traps should be stored in watertight containers in the bed of a pickup truck or in a supply shed.

Multilure Trap Maintenance

Clean traps every 6 weeks when the lure and capture liquid are replaced or more frequently if necessary. The best cleaning method is to use soapy water: 1 to 2 T of gentle dish detergent like Dawn in 5 gallons of water is sufficient. In some cases, it may be necessary to soak the traps overnight to loosen sticky substances and debris. Rinse the traps thoroughly in clean water and wipe or air dry before reusing. **DO NOT USE CHEMICAL CLEANERS FOR REMOVAL OF THE STICKY SUBSTANCES**. These products may act to deter flies and thus render the trap less effective.

Table 3-4 Common Target Flies and Corresponding Lures for Multilure Trap

Multilure Trap Target Flies	**Corresponding Lure**
· *Anastrepha ludens* · *Anastrepha suspensa* · *Anastrepha* spp. · *Bactrocera* spp. · *Ceratitis capitata* · *Zeugodacus* spp.	Torula yeast and borax dissolved in water
· *Anastrepha ludens* · *Anastrepha suspensa* · *Anastrepha* spp.	Two-component lure · Putrescine · Ammonium acetate

Multilure Trap Target Flies	Corresponding Lure
· *Ceratitis capitata* · *Ceratitis* spp.	Three-component lure · Putrescine · Ammonium acetate · Trimethylamine

Jackson Trap

The Jackson trap is a triangular (delta-shaped) trap made of plastic-coated cardboard. The trap consists of five parts: trap body, sticky insert, wick holder or plastic basket, lure wick or solid lure, and trap hanger. Trap hangers are reusable and should be saved. The sticky insert on the bottom captures the flies.

This trap is mostly used with a male attractant with or without an insecticide, depending on the size and flight ability of the fly and its propensity to escape the trap. If the solid lure is used, it is contained in a plastic basket suspended from the hanger inside of the Jackson trap. For liquid lures, a cotton wick is dipped in the lure solution until it is saturated and is then supported inside the trap by a wire wick holder.

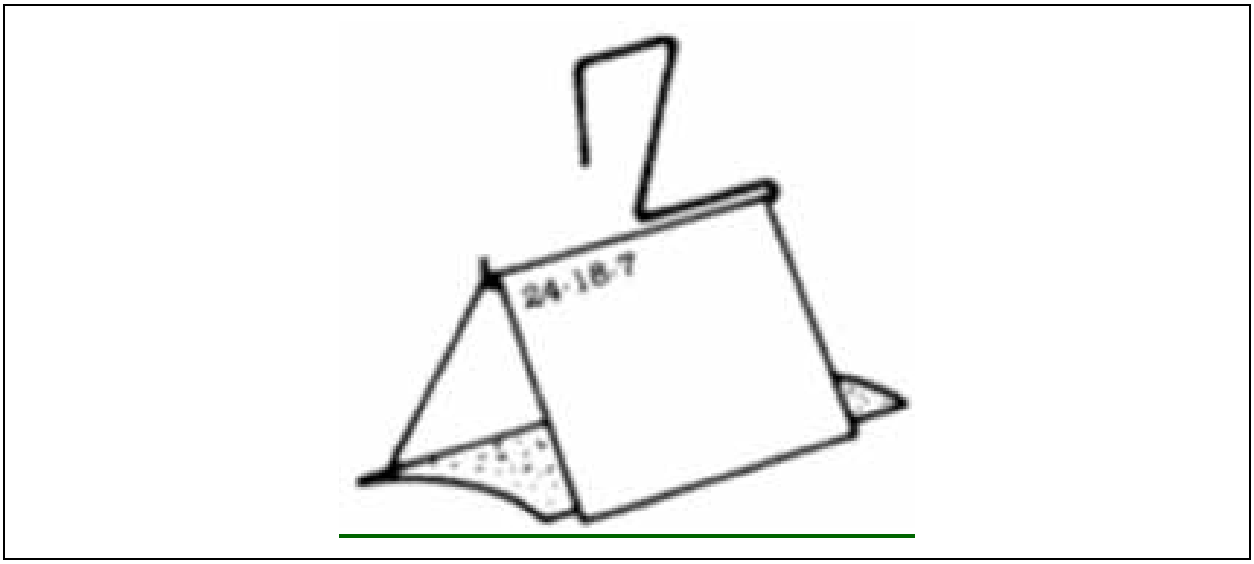

Figure 3-5 Jackson Trap

Attractants for Jackson Trap: Male Attractants

Male attractants, most of which are para-pheromones (including cuelure, methyl eugenol, and trimedlure) are used in Jackson traps as either solid plugs or wicks with liquid lure. Plugs are placed into a plastic basket and placed onto the hanger. Both methyl eugenol and cuelure attractants have an insecticide (dibrom or dichlorvos [2,2-dichlorovinyl dimethyl phosphate or DDVP]) paired with them for quick knock-down because the targeted flies are strong fliers. There is no insecticide paired with trimedlure attractant.

Two types of Jackson Trap bodies are available:

- Trap bodies **with** the label “Caution Toxic Material” are used for Cuelure / DDVP (solid) or dibrom (liquid) and ME / DDVP (solid) or dibrom (liquid)baited traps.
- Trap bodies **without the** label “Caution Toxic Material” are used for TML baited traps.

Capture Agents for Jackson Trap: Sticky Board Insert

The sticky insert is coated with an adhesive, Stikem Special, and is inserted at the bottom of the Jackson trap. When flies enter the trap, they stick to the sticky board insert.

Servicing and Baiting Jackson Traps

Change inserts every 2 or 3 weeks during the baiting cycle of the trap or more often if needed. Always change and label the insert undersurface when relocating the trap. Insert **must** be identified by trap number for identification purposes.

Generally, lures should be changed every 6 weeks, at a minimum, or as often as program practices dictate. Trap bodies eventually lose their shape, become covered with trap servicing data, or otherwise deteriorate. Trap bodies should be replaced before this occurs.

NOTICE

If using liquid lure, water (moisture) can physically force the lure chemical out of the wicks and contaminate the traps. Wicks that become wet from rain, sprinklers, etc., should be replaced.

To service Jackson traps:

- Remove the trap from the tree.
- Pull out the insert and examine entire area of insert, including the bottom of insert. This step should be done before attending to other trap servicing details.
- Remove leaves and debris from sticky board insert since flies could be beneath these objects. Be certain that the sticky surface is **not** rendered less effective by dust or debris. The sticky board insert **must** remain optimally sticky to capture flies. When flies are detected on the sticky board insert, remove sticky board insert from trap body, follow program approved specimen submittal process.

Baiting Jackson Traps with Plugs

Place the lure and DDVP square (**not** needed with trimed lure) in the lure baskets and slide the basket on to trap hanger.

Write the trap number on the nonsticky side (bottom) of the insert. Make sure the sticky surface is adequately covered with adhesive material (Stikem Special).

Bow the sticky side upward and insert in the trap. Number the trap body before hanging.

Insert the trap hanger at the top of the trap, making sure it is properly inserted.

Figure 3-6 Baiting Jackson Traps with Plugs

Baiting Jackson Traps with Wicks

- Insert the trap hanger at the top of the trap. Do **not** bend the hanger; it is brittle and will break easily.
- Put a 90-degree bend in the wick holder 1 inch from the end. Insert the wick and bait with 6 ml of liquid lure.
- Insert the wick holder on the side of the trap, ensuring the wick does **not** touch the side wall and is midway inside the trap.
- Write the trap number on insert undersurface.
- Bow the sticky side upward and insert in the trap. Number the trap body before hanging.

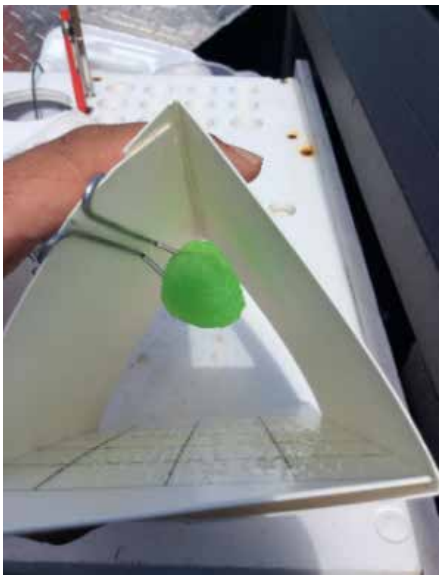

Figure 3-7 Baiting Jackson Traps with Wicks

Keep liquid lure in a darkened bottle. A calibrated medicine dropper or a pipette is recommended for application of the lure to the wick. The wick is initially baited with 5 to 6 ml of lure. One-half of the lure is applied to each end of the wick (3/4” x 1"). Change wick every 6 weeks. Reusing the wick is **not** recommended. This lure contains either 1% or 5% Dibrom® to ensure that flies are killed and held in the sticky board insert. The lure and toxicant are mixed by program staff and issued to trappers. If possible, baiting of new traps should be done at a workstation where safety and contamination can be addressed more readily.

⚠ CAUTION

Properly label cuelure and methyl eugenol lure containers with a poison label, dated, and stored properly out of reach of children and animals.

Use latex or other protective gloves when handling lures and wicks containing dibrom.

Use safety goggles/face shield when mixing or pouring liquid lures. Know and follow the product labels and safety data sheets.

Table 3-5 Example of Servicing and Rebaiting Interval*

Jackson Trap						
		Service		Service		Service & Rebait
Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42

*Terminology: Service = check for and remove all trapped flies and debris, replace sticky board insert if necessary; Rebait = replace lure and sticky board insert.

Table 3-6 Common Target Flies and Corresponding Lures for Jackson Trap

Jackson Trap Target Flies and Corresponding Lure	
Target Fly	Lure
Ceratitis spp.	Trimedlure No killing agent necessary
Bactrocera tryoni *Bactrocera frauenfeldi* *Zeugodacus cucurbitae* *Bactrocera* and *Zeugodacus* spp.	Cuelure with killing agent (DDVP or Dibrom)
Bactrocera correcta *Bactrocera zonata* Additional *Bactrocera* spp.	Methyl eugenol with killing agent (DDVP or Dibrom)

Yellow Sticky Card Trap

Yellow sticky card traps, also known as yellow panel traps, are paper traps with a grid and an adhesive surface. The yellow color is attractive to flies. These traps, coupled with an ammonium acetate lure in a basket, are commonly used to monitor *Rhagoletis* spp. by hanging them on woody host plants. The flies become stuck in the adhesive.

Figure 3-8 Yellow Stick Card Trap

Attractants for yellow sticky card trap

Protein baits, such as ammonium acetate, ammonium bicarbonate, or ammonium carbonate, are used with yellow sticky cards. These baits are most often formulated as solid dispersers.

Capture Agents: Adhesive Paste

Yellow sticky cards are coated with adhesive to capture insects. The adhesive is impregnated with a protein bait which will attract flies and stimulate feeding in combination with the lure.

Servicing and Baiting Yellow Sticky Card Traps

To service the yellow sticky cards:

- Remove the trap from the tree.
- Remove leaves and debris from sticky board, since flies could be beneath these objects. Be certain that the sticky surface is **not** rendered less effective by dust or debris. When flies are detected on the trap, remove and replace the trap. Follow program-approved specimen submission process and include all required information such as date of service and trap ID.

Figure 3-9 Package of ammonium acetate lures for yellow sticky card traps

Change yellow sticky cards every 2 or 3 weeks during the baiting cycle of the trap or more often as needed. Always change the sticky card when relocating the trap. Card **must** be identified by trap number as well for identification purposes. Generally, lures should be changed every 6 weeks or as often as program practices dictate.

To bait: remove lure cap and hang on yellow sticky card.

Table 3-7 Example of Servicing and Rebaiting Interval

Yellow Stick Card Trap						
		Service		Service		Service & Rebait
Day 0	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42

*Terminology: Service = replace yellow sticky card; Rebait = replace lure.

Common Target Flies and Corresponding Lures for Yellow Sticky Cards Trap

Target fly: *Rhagoletis cerasi*

Lure: Ammonium acetate, Ammonium bicarbonate, Ammonium carbonate

Chapter 4

Descriptions of Fruit Fly Species

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Related Links

Refer to the APHIS-USDA website for general pest information.

Refer to the APHIS-USDA website for the regulated host list.

Mexican Fruit Fly (*Anastrepha ludens*)

The Mexican fruit fly (Mexfly) is a serious pest of citrus, mango, and various other commercial fruit crops, throughout Mexico and Central America. It is known to be a recurrent pest in the United States in southern California and southern Texas, but it is eradicated whenever it is detected. An established infestation of Mexfly could severely harm production and marketability of domestic citrus fruits and cause significant industry losses. APHIS and cooperators maintain survey, regulatory, and control programs, including a preventive release sterile insect technique program in Texas.

Source: Florida Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services UGA5193047
http://www.bugwood.org

Figure 4-1 Mexican Fruit Fly

Diagnosis and General Biology

The adult is slightly **larger than** a housefly (7 to 12 mm long) and is mostly yellow to orange in color. The Mexfly is similar in appearance to other members of the genus *Anastrepha* (refer to South American Fruit Fly (*Anastrepha fraterculus*)) but notable compared to the other pest species for the female's long ovipositor relative to its body size (1.1 to 1.5 times as long as the thorax). In nature the average life cycle takes about 3 months with 3 generations developing annually. There can, however, be up to 12 generations a year. The Mexfly female punctures the rind or skin of fruits and inserts 2 to 10 eggs. A single female may produce several hundred eggs. Larvae pupate 3 to 5 cm deep in the soil.

Distribution

Mexfly occurs in Mexico and throughout Central America. It is detected in Texas frequently but is under official control and eradication. This species is subtropical rather than tropical.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure.

South American Fruit Fly (*Anastrepha fraterculus*)

South American fruit fly is a complex of cryptic species, several of which are serious pests of cultivated fruits in many parts of South America. In some areas, populations of this complex are the most injurious species of the genus *Anastrepha*. In Argentina it is the most important pest in all citrus areas. It attacks many fruits as well as some vegetables and nuts.

Source: https://entnemdept.ufl.edu/creatures/fruit/tropical/south_american_fruit_fly.htm

Figure 4-2 South American Fruit Fly

Diagnosis and General Biology

South American fruit fly adults are **larger than** a house fly (about 12 mm long). The female has a stout ovipositor **shorter than** the abdomen. The body is yellow to orange with 3 white to pale yellow stripes on the thorax, a brown spot on the suture between the scutum and scutellum, and a pair of brown marks on the posterior end of the thorax (**not** visible in dorsal view). The wing has 3 orange and brown bands (costal band, S-band, and V-band) on a clear base.

The life cycle of the South American fruit fly varies considerably by season as well as by region. Up to 50 eggs may be oviposited in a single fruit. Adults live about a month. The egg stage lasts about 3 days in summer and 6 days in winter. Larval development is completed in 15-20 days in summer and up to 25 days in winter. In exceptional cases, adults have been known to emerge from pupae after 12, 14, and 18 months.

Distribution

The South American fruit fly complex occurs in Mexico and throughout Central and South America (**except** Chile) and Trinidad and Tobago in the Caribbean. South American fruit fly has been detected in the United States on occasion but is **not** established there.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure.

West Indian Fruit Fly (*Anastrepha obliqua*)

West Indian fruit fly is one of the most serious pests of mango in the American tropics and attacks various other commercial fruits.

Figure 4-3 West Indian Fruit Fly

Diagnosis and General Biology

West Indian fruit fly adults are very difficult to separate from South American fruit flies, as they have similar coloring and patterns (refer to South American Fruit Fly (*Anastrepha fraterculus*)). They differ in markings on the posterior side of the thorax and lack the brown spot on the suture between the scutum and scutellum. Specimens should be referred to a specialist, as dissection of the aculeus (ovipositor piercer) on a female may be necessary to confirm identification.

West Indian fruit flies lay eggs singly beneath the skin of host fruits, where the eggs hatch within 3 to 12 days. Larvae feed for another 15 to 32 days and then pupate in the soil for 15 to 19 days (longer in cool temperatures) before emerging as adults. Adults occur throughout the year.

Distribution

West Indian fruit fly occurs in Mexico, throughout Central America and South America (**except** Chile and Uruguay), and the Caribbean islands (**except** Bermuda). West Indian fruit fly has been

detected in Bermuda but is **no** longer present; the fly has been detected in the mainland United States on occasion but has always been eradicated. It is established in Puerto Rico.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure.

Sapote Fruit Fly (*Anastrepha serpentina*)

The sapote fruit fly prefers mamey, sapote, sapodilla, star apple, and other tropical sapotaceous fruits imported for the U.S. market. It occasionally attacks citrus and some other commercial fruits.

Source: A. Norrbom et al., Systematic Entomology Laboratory. 5486395 http://www.bugwood.org

Figure 4-4 Sapote Fruit Fly (*Anastrepha serpentina*)

Diagnosis and General Biology

Sapote fruit flies are slightly **larger than** a house fly (7.5 to 10.3 mm long) and are predominantly dark brown with white to yellow markings, including a characteristic white T-shaped mark on the abdomen. Sapote fruit fly lacks the more apical part of the V-band (inverted V-shaped band across cross-vein dm-cu and doubling back across vein M). Instead, the V-band is reduced to a marking along cross-vein dm-cu. Sapote fruit flies have a relatively long ovipositor (0.75 to 1.05 times as long as the thorax). Sapote fruit flies lay eggs under the skin of host fruits, where they hatch after 3 days. The larvae feed for an additional 8 to 13 days, then pupate in the soil for 13 to 17 days before emerging as adults.

Distribution

Sapote fruit fly occurs in Mexico and throughout Central America and South America (**except** Chile and Uruguay) and in Dominica, Netherlands Antilles (Curaçao), and Trinidad and Tobago

in the Caribbean islands. Sapote fly is occasionally detected in the United States; these potential colonizers are always eradicated.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure.

New World Guava Fruit Fly (*Anastrepha striata*)

New World guava fruit fly is a pest of guavas and other myrtaceous fruits. It occasionally attacks citrus, mango, and some other commercial fruits.

source: A. Norrbom et al., Systemic entomology Laboratory 5486452 http://www.bugwood.org

Figure 4-5 New World Guava Fruit Fly (*Anastrepha striata*)

Diagnosis and General Biology

New World guava fruit fly adults are about the size of a house fly (5.9 to 7.7 mm long) and predominantly yellow to orange. They are distinguishable by the combination of a U-shaped dark brown pattern on the thorax and a short aculeus that lacks apical serrations. New World guava fruit fly infests guava year-round, but population dynamics depend on the geographic area.

Distribution

New World guava fruit fly occurs in Mexico, throughout Central America and South America (**except** Argentina, Chile and Uruguay) and in Netherlands Antilles (Curaçao) and Trinidad and Tobago in the Caribbean islands. The species is occasionally detected and eradicated from the United States.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure

Caribbean Fruit Fly (*Anastrepha suspensa*)

Caribbean fruit fly (Caribfly) is a pest of guavas and other myrtaceous fruits. It frequently attacks overripe citrus, peaches in Florida, and a wide variety of other commercial fruits.

Source: Florida Division of Plant Industry Dept. of Agriculture and Consumer Services5193010 http://www.bugwood.org

Figure 4-6 Caribbean Fruit Fly (*Anastrepha suspensa*)

Diagnosis and General Biology

Caribfly adults appear very similar to South American fruit fly and many other *Anastrepha* species (up to 12 to 14 mm long). They are yellow to orange with 3 white to pale yellow stripes on the thorax and almost always have a distinct brown spot on the suture between the scutum and scutellum. The wing bands are relatively broad compared to South American fruit fly, with the band along the anterior apical wing margin usually reaching vein M1.

Caribfly females lay eggs under the surface of the peel of a host. These eggs hatch in 2 to 3 days. Larva feed on the flesh of the host for 10 to 14 days, then pupate under the soil. Adults emerge from puparia after 10 to 14 days. Emerged adults reach maturity in 14 days. Development times may be prolonged by cool weather.

Distribution

Caribfly is known from the Greater Antilles, Bahamas, Cayman Islands, Puerto Rico, Virgin Islands, and Florida, U.S.

Preferred Trap and Lure

Multilure trap with two-component lure or McPhail trap with torula yeast lure.

Carambola Fly (*Bactrocera carambolae*)

Carambola fly is a polyphagous pest with **more than** 100 host plants including avocado, guava, lemon, mango, orange, and papaya. Though carambola fly is native to Malaysia, Indonesia, and surrounding areas, it has also invaded South America and become established in Brazil. Carambola fly is closely related to Oriental fruit fly and may be difficult to distinguish from it via morphology alone.

Source: Pest and Diseases Image Library 5189094 http://www.bugwood.org

Figure 4-7 Carambola Fly (*Bactrocera carambolae*)

Diagnosis and General Biology

Carambola flies are slightly **larger than** a house fly (7.5 to 9.5 mm long) and have a predominantly black or dark fuscous body, often with a reddish-brown pattern. The thorax has two bright yellow stripes at the base of each wing and there is a “T-shaped” dark pattern present on the abdomen. Some carambola flies are morphologically difficult to distinguish from Oriental fruit fly. Unlike Oriental fruit fly, the wing costal band is broadened apically, and small brown spots are usually present at the bases of fore femora. A DNA analysis is necessary to confirm identification.

Carambola flies females lay eggs under the surface of the skin of a host. These eggs develop into adults in an average of 19 to 26 days depending on host. The larva feed for an average of 9 to 11 days before pupation, adults emerge from puparia after 9 to 14 days. Emerged adults reach maturity in 14-20 days. Development times may be prolonged by cool weather.

Distribution

Carambola fruit fly occurs in Southeast Asia (Brunei, Cambodia, Indonesia [Java, Sulawesi], Malaysia, Singapore, Thailand, and Vietnam), in southern Asia (Bangladesh, India [Andaman Island Group]), and in South America (French Guyana and Suriname). It has been repeatedly detected and eradicated from Brazil.

Preferred Trap and Lure

Jackson trap with methyl eugenol, Multilure or McPhail trap with torula yeast.

Guava Fruit Fly (*Bactrocera correcta*)

Guava fruit fly is a polyphagous pest with **more than** 100 host plants including guava, citrus, mango, and peach. It is widely distributed through Southeast Asia and has a similar range to its close relative, peach fruit fly. Guava fruit fly is occasionally detected in both California and Florida but has always been eradicated.

Source: Jeff Lotz, FL Division of Plant Industry. https://entnemdept.ufl.edu/creatures/fruit/tropical/guava_fruit_fly.htm

Figure 4-8 Guava Fruit Fly (*Bactrocera correcta*)

Diagnosis and General Biology

Guava fruit fly adults are about the size of a house fly (5 to 6 mm long) and are morphologically similar to Peach fruit fly by having **no** costal band, and **only** isolated black dots on the wing apex. Guava fruit flies are distinguishable from Peach fruit fly by the darker color of the thorax, the yellow scutellum, and the facial spots being united, or almost so, to form a black transverse band. A less developed whitish-cross band is present on the second abdominal segment.

Guava fruit fly eggs take an average of 3 days to hatch and the larval stage lasts an average of 19 days. They then pupate below the soil surface where they remain for an average of 7 days. Newly emerged females require about 2 weeks to mature before they can begin to oviposit. Cooler temperatures may extend these development periods. Adults usually live for about 1 to 3 months but have survived up to one year in cool mountain localities.

Distribution

Guava fruit fly occurs in Bangladesh, Bhutan, Cambodia, China, India, Laos, Malaysia, (Peninsular), Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, and Vietnam. Guava fruit fly has been detected in the United States but is always eradicated.

Preferred Trap and Lure

Jackson trap with methyl eugenol, Multilure or McPhail trap with torula yeast.

Oriental Fruit Fly (*Bactrocera dorsalis*)

Oriental fruit fly (OFF), the most destructive pest among Dacine fruit flies, was introduced into the Hawaiian Islands about 1945, and by 1948 had increased to high population numbers. In Hawaii, OFF is destructive to all marketable fruit crops **except** pineapple and strawberries. It is likely that OFF could survive and reach damaging numbers in areas of California, Texas, and Florida.

Source: Florida Division of Plant Industry Archive Florida Department of Agriculture and Consumer Services 5311069
http://www.bugwood.org

Figure 4-9 Oriental Fruit Fly (*Bactrocera dorsalis*)

Diagnosis and General Biology

OFF is morphologically very similar to carambola fly but can sometimes have a completely reddish thorax. A DNA analysis is necessary to confidently differentiate this species from its close relatives.

One generation is approximately 21 days minimum. Eggs may take **only** 24 hours to hatch, but at cooler temperatures can require up to 20 days. The larval stage may last from 6 to 35 days

depending on the temperature. They then pupate 2 to 5 cm (rarely up to 13 cm) below the soil surface. The pupal stage usually takes 10 to 12 days to complete; OFF usually overwinters in this stage for up to 120 days. Newly emerged females normally require about 8 to 12 days to mature before they can begin to oviposit. Adults usually live for about 1 to 3 months but have survived a year in cool mountain localities.

Distribution

OFF is native to and present in many tropical and subtropical countries in Asia. From there it spread throughout Oceania and Africa. Its presence has also been verified in Oman, United Arab Emirates, and Hawaii, USA. Prior infestations in the United States (California), Cook Islands, the Mariana Islands, Nauru, and Japan (the Ryukyu Islands) were eradicated.

Preferred Trap and Lure

Jackson trap with methyl eugenol, Multilure or McPhail trap with torula yeast.

Mango Fruit Fly (Bactrocera frauenfeldi)

Mango fruit fly is a polyphagous pest that has been reared from 73 host plant species in 31 different families. These include economically important fruits like mango, guava, citrus, and avocado. In 2022, scientists used molecular analysis to determine that the white-striped fruit fly, *B. albistrigata*, is a synonym of the mango fruit fly. This species is widespread across Australasia and Southeast Asia and has variable morphology across its range.

Source: Pest and Diseases Image Library 5460317 http://www.bugwood.org

Figure 4-10 Mango Fruit Fly (*Bactrocera frauenfeldi*)

Diagnosis and General Biology

Mango fruit flies are about the size of a house fly (6 to 7.5 mm long). They have round facial spots and a scutum that is predominantly black with a white stripe in the middle and two bright

yellow stripes at the base of each wing (shoulders) **only**. The scutellum has a narrow to extensive median triangular black mark, while there are two brown bands across the wing.

Mango fruit fly takes a minimum of 21 days to complete a generation. Eggs may take **only** 24 hours to hatch, but at cooler temperatures may take longer. The larval stage may last from 10 to 35 days depending on the temperature. They then pupate below the soil surface where pupae remain for 10 to 30 days. Newly emerged females normally require about 1 to 2 weeks to mature before they can begin to oviposit. Adults usually live for about 1 to 3 months but have survived a year in cool mountain localities.

Distribution

Mango fruit fly occurs in Australia (Queensland), Federated States of Micronesia, India (Andaman Island Group), Indonesia, Kiribati (Gilbert Islands), Malaysia (Peninsular), Marshall Islands, Palau, Papua New Guinea, Philippines, Singapore, Solomon Islands, and Thailand. Mango fruit fly was once detected in the United States but never established and is **no** longer present.

Preferred Trap and Lure

Jackson trap with Cue-lure, Multilure or McPhail trap with torula yeast.

Solanum Fruit Fly (*Bactrocera latifrons*)

Solanum fruit fly is a polyphagous pest that attacks 59 hosts from 14 plant families but is primarily a pest of solanaceous and cucurbit plants. Host range testing indicates that solanum fruit fly prefers peppers (*Capsicum* spp.) over other hosts. In its native range, solanum fruit fly has been recorded infesting up to 80% of a pepper crop. Solanum fruit fly has been detected and eradicated in California but has become established in Hawaii.

Source: Natasha Wright, Florida Department of Agriculture and Consumer Services 5189095 http://www.bugwood.org

Figure 4-11 Solanum Fruit Fly (*Bactrocera latifrons*)

Diagnosis and General Biology

Solanum fruit flies are about the size of a house fly. They are generally similar to OFF but have a rust brown abdomen (sometimes can be dark) with **no** distinctive T-shaped dark pattern. The thorax is reddish brown with bright yellow stripes, wings have a costal band connected to a black spot at the tip of each wing. Legs are predominantly yellow with some brown markings on femora. The aculeus wing dark band is noticeably broadened at its apex.

Under laboratory conditions, eggs are laid beneath the skin of host fruit, and eggs hatch within a few days (mean 2.3). Larvae feed for a mean of 8.5 days, pupation occurs in soil, and the pupal stage lasts a mean 10.2 days. Adults occur year-round.

Distribution

Solanum fruit fly occurs in Bangladesh, Bhutan, Brunei, China, Hong Kong, India, Indonesia, Japan, Kenya, Laos, Malaysia, Pakistan, Singapore, Sri Lanka, Taiwan Island, Tanzania, Thailand, and Vietnam. In the United States it has been eradicated from the contiguous States but occurs in Hawaii.

Preferred Trap and Lure

Multilure or McPhail trap with torula yeast.

Chinese Citrus Fly (*Bactrocera minax*)

The Chinese citrus fly causes significant damage to tangerine in India. It is native to China and has been recorded from multiple different species of citrus.

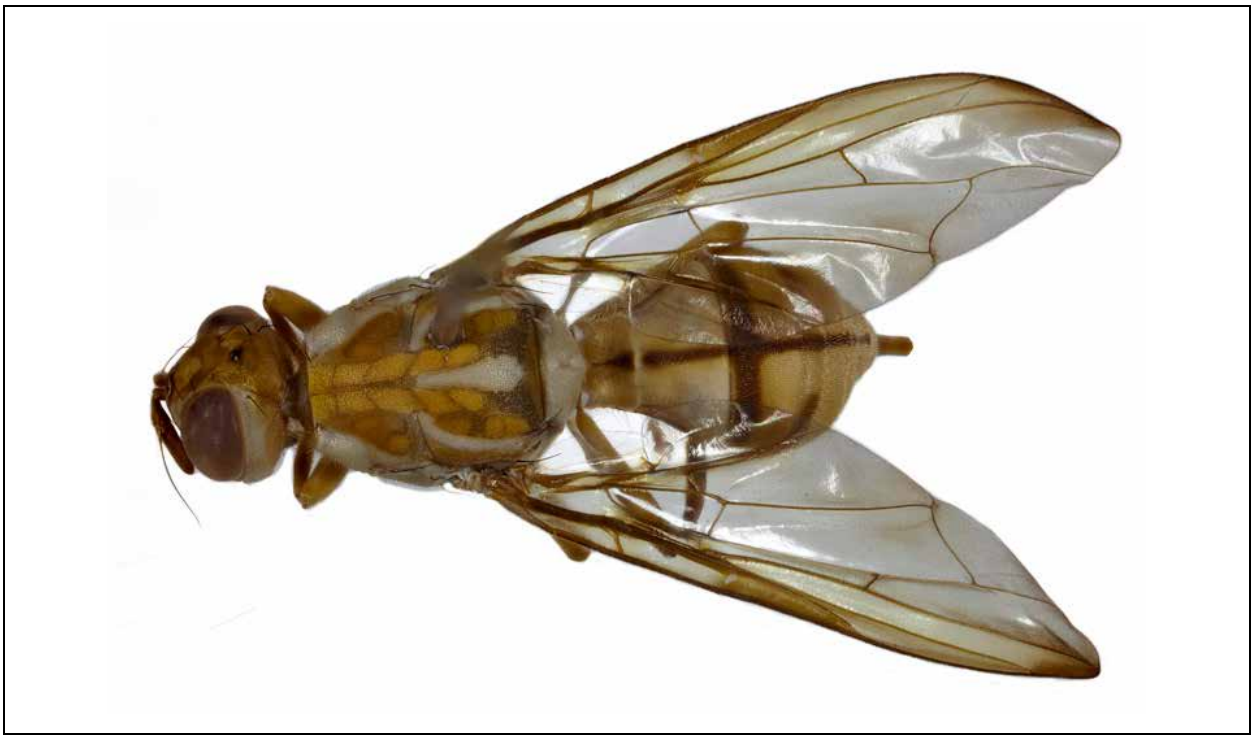


Figure 4-12 Chinese Citrus Fly (*Bactrocera minax*)

Diagnosis and General Biology

Chinese citrus fly is a larger species (13 to 15mm). It is orange to brown colored, with 3 pale whitish to yellow stripes on its thorax. The yellow abdomen has a distinctive black “T” pattern. Wings have a yellow pattern along the costa with a dark spot on the tip. The pest is univoltine, with adults emerging during April to May and overwintering as pupae.

Distribution

Chinese citrus fly occurs in Bhutan, China (Guangxi, Guizhou, Hubei, Hunan, Jiangsu, Sichuan, Yunnan), India (Sikkim, West Bengal), and Nepal.

Preferred Trap and Lure

Multilure or McPhail trap with torula yeast.

Queensland Fruit Fly (*Bactrocera tryoni*)

Queensland fruit fly (Qfly), a serious pest of pome (apple, pear, etc.) and stone (peach, apricot, etc.) fruits in eastern Australia, may be destructive to some citrus varieties during peak population years. An outbreak in New South Wales during 1940-41 caused rejection of 5% to 25% of the citrus at harvest. The fly appears to be as destructive to fruit production in Australia as the Oriental fruit fly is in the countries of its range. Commercial stone fruit orchards have been abandoned in Queensland due to this pest.

Source: Natasha Wright, Braman Termite & Pest Elimination, Bugwood.org
https://www.invasive.org/browse/detail.cfm?imgnum=5189097

Figure 4-13 Queensland Fruit Fly (Bactrocera tryoni)

Diagnosis and General Biology

The adult female of Qfly is about the size of a house fly (6 mm long), has a mean wing expanse of 10 to 12 mm, and body coloration is reddish-light brown marked with yellow. The dorsum of the thorax has a double narrow yellow stripe on either side and a yellow scutellum, and the abdomen is sometimes significantly **darker than** the thorax.

The pre-ovipositional period for Qfly averages 2 weeks. Up to 7 eggs are laid in a group in fruit punctures. As many as 40 larvae have been found in one peach. Under favorable conditions, eggs hatch in 2 to 3 days. Larvae are full grown in 5 to 7 days. Pupae remain in the soil from a week in warm periods to a month or more in cooler periods. The total life cycle requires about 2 to 3 weeks in summer to 2 months in autumn. Because adult females can live for prolonged periods, 4 or 5 overlapping generations can develop annually. Overwintering is in the adult stage.

Distribution

Qfly occurs in Australia in the States of New South Wales, Queensland, South Australia, and Victoria. In the Pacific, it was introduced to French Polynesia, New Caledonia, and Pitcairn Island. Invasions of Cook Islands and Easter Island have been promptly eradicated. It has been detected and eradicated in California.

Preferred Trap and Lure

Jackson trap with Cue-lure, Multilure, or McPhail trap with torula yeast.

Peach Fruit Fly (*Bactrocera zonata*)

Peach fruit fly is a pest mainly on stone fruits, mango, guava, and papaya, but it can be found on many other wild and cultivated fruits, including citrus. It is native throughout South and Southeast Asia and shares a distribution range with its close relative the guava fruit fly. Peach fruit fly is occasionally detected and eradicated in both California and Florida.

Source: Natasha Wright, Florida Department of Agriculture and Consumer Services 5189098 http://www.bugwood.org

Figure 4-14 Peach Fruit Fly (*Bactrocera zonata*)

Diagnosis and General Biology

The adult peach fruit fly is about the size of a housefly (5 to 6 mm). It is somewhat similar to guava fruit fly, having transparent wings with a small brown spot on the tip of each wing, but it is completely reddish brown, with yellowish abdominal crossbands in a T-shaped pattern and two separate round facial spots.

Peach fruit fly development from egg to adult, at optimum temperatures of 27°C and a relative humidity of 70%, takes approximately 10 days. Adults are strong fliers and can be active any time of the year when temperatures exceed 10 °C. The adult usually becomes sexually mature 8 to 16 days after emergence. The minimum period of time for one generation is approximately 20 days. The female lays batches of 2 to 9 eggs beneath the skin of the host fruit which hatch in 2 to 3 days. Larvae feed on the fruit for 1 to 3 weeks, and then emerge to pupate 2 to 15 cm deep in the ground. The pupal period varies from 4 days in summer to over 6 weeks in winter.

Distribution

Peach fruit fly is native to East Asia and is present in several Asian countries (Bangladesh, Bhutan, India, Indonesia, Laos, Nepal, Myanmar, Pakistan, Sri Lanka, Taiwan, Thailand, and Vietnam). It has been gradually spreading eastwards and now occurs in the Middle East and North Africa (Algeria, Egypt, Gaza Strip, Iran, Lebanon, Libya, Oman, Saudi Arabia, Syria, United Arab Emirates, and Yemen). It also occurs in Brazil, Mauritius, Philippines, and Réunion, and has been detected in and eradicated from Israel and the United States.

Preferred Trap and Lure

Jackson trap with methyl eugenol, Multilure or McPhail trap with torula yeast

Mediterranean Fruit Fly (*Ceratitis capitata*)

The Mediterranean fruit fly (Medfly) is a widespread and destructive pest of citrus and numerous vegetables and other fruits. Medfly has been eradicated from the United States many times. APHIS and cooperators maintain survey, regulatory, and control programs, including preventive release sterile insect technique programs in California and Florida.

Source: Scott Bauer, USDA-ARS 1317085 http://www.bugwood.org

Figure 4-15 Mediterranean Fruit Fly (*Ceratitis capitatis*)

Diagnosis and General Biology

Adult Medfly are slightly **smaller than** a housefly (3 to 5mm) and have a whitish gray head, a black thorax with yellow and white patches and lines, and a flattened round yellowish abdomen with 3 gray bands. The wings have a characteristic oval shape and pattern of 3 yellowish bands and a web of black lines and spots at the base.

One Medfly generation under favorable conditions is 21 to 33 days at a 26 °C optimum temperature. Development in the egg, larval, and pupal stages of Medfly is greatly reduced or arrested at temperatures below 10 °C. The pupal stage may allow the species to survive unfavorable conditions, such as lack of food and water and temperature extremes.

Distribution

Native to East Africa, the Medfly has spread to the rest of Africa, all countries bordering the Mediterranean Sea, Australia, Central America, South America, Europe, Hawaii, and various islands in the Pacific. Medfly has been intercepted in China, Czech Republic, Estonia, India (no longer present), Lithuania, Luxembourg (**no** longer present), Netherlands (**no** longer present), Romania, Slovakia, Sweden and the United Kingdom (**no** longer present). Adventive populations are **no** longer present in Austria, Belgium, Germany and Hungary. Medfly has been eradicated from Belize, Bermuda, New Zealand, Ukraine, and the United States (California and Florida). Records of Medfly presence in Jamaica and Puerto Rico are erroneous.

Preferred Trap and Lure

Jackson trap with trimedlure, Multilure (3-component) or McPhail trap with torula yeast

European Cherry Fruit Fly (*Rhagoletis cerasi*)

European cherry fruit fly (ECFF) is an economic pest of sweet cherry. In European orchards, ECFF may infest 100% of cherries in an untreated orchard. ECFF was discovered in Ontario in 2015 and in Niagara County, New York, in 2018. In New York it infests native and invasive honeysuckle (*Lonicera* spp.).

Source: Alison Morris UGA5584636 http://www.bugwood.org

Figure 4-16 European Cherry Fruit Fly (*Rhagoletis cerasi*)

Diagnosis and General Biology

Adult ECFF are about the size of a housefly (3.5 to 6.5 mm). They have a predominantly dark brown to black body with a white to yellow scutellum and a yellow to brown head. ECFF wings are clear with 4 broad and 1 narrow dark band. Within the invaded ranges of New York and Canada, it should be easily distinguishable from other captured species.

ECFF has one generation per year and feeds on a few different host species. It overwinters as diapausing pupae in soil near to the host (cherry or honeysuckle). Fly emergence usually occurs from late May to mid-June when temperatures are above 15 °C. Most adults emerge at the conclusion of 1 cycle of winter diapause. The period of adult emergence, flight, mating and oviposition can range from 7 to 11 weeks based on fly fitness, host phenology and ambient temperatures. Estimates of the life span of adults in the field range from 4 to 7 weeks.

A single egg (normally) is oviposited into host fruit where it develops in 2 to 10 days, depending on temperature. The larva develops within the fruit though 3 instars. At the end of larval development, pre-pupal larvae emerge from host fruit, drop to the soil below, and burrow to a depth of 2 to 5 cm beneath the surface to pupate where they overwinter in the pupal stage. Most hosts are perennial plants.

Distribution

ECFF occurs throughout temperate regions of Europe. It is now established in Canada (Ontario and Quebec) and in the USA (New York), where it is under active quarantine.

Preferred Trap and Lure

Yellow sticky panel baited with ammonium acetate.

Melon Fly (*Zeugodacus cucurbitae*)

Melon fly (*Zeugodacus cucurbitae*) originated in Asia where, in some places, it is the most destructive pest of cucurbits. This species has significantly restricted production of melons, cucumbers, tomatoes, and other vegetables in Hawaii following its introduction (as early as 1895). Entire fields of Hawaiian watermelons have been killed before the plants reached 20 cm in length. A loss of **more than** 95% of the pumpkins was reported in Hawaii in the early days of the infestation. India, likewise, has reported 50% destruction of vegetable crops.

Source: Pes and Diseases Image Library 1317036 http://www.bugwood.org

Figure 4-17 Melon Fly (*Zeugodacus cucurbitae*)

Diagnosis and General Biology

Melon fly adults are slightly **longer than** a housefly (6 to 8 mm). They are reddish, with 3 yellow stripes on the thorax with a distinctive pattern of brown bands and spots along the wing veins. Melon fly development from egg to adult under an optimum temperature of 27°C and 70% relative humidity takes approximately 12 days. Under optimum conditions, one generation can complete in about 21 days. Females live 3 to 5 months. The shortest length of time for one generation is about 12 days, but it is usually about 1 to 2 months.

A mated female melon fly may deposit an average of 15 eggs per day for a month or more. The eggs take 6 to 28 hours to hatch. The larvae go through 3 instars in 4 to 17 days. They drop to the ground and pupate 2 to 5 cm under the soil surface. The pupal stage usually lasts 7 to 13 days but may last up to 59 days in cold weather.

Distribution

Melon fly is native to Asia and occurs throughout many tropical countries of Asia (Bangladesh, Bhutan, Brunei, Cambodia, China, India, Indonesia, Japan (Okinawa), Laos, Malaysia (Peninsular, East), Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, Taiwan, and Vietnam), Africa (Benin, Burkina Faso, Burundi, Cameroon, Comoros, Democratic Republic of the Congo,

Gambia, Ghana, Guinea, Ivory Coast, Kenya, Mali, Mauritius, Niger, Nigeria, Senegal, Seychelles, Sudan, Tanzania, Togo, and Uganda), and Oceania (Australia (Torres Strait Islands), Papua New Guinea, the Philippines, and Solomon Islands). It occurs in the United States (Guam, Hawaii, and Northern Mariana Islands). Invasive populations on Nauru and Kiribati (Christmas Island) have been eradicated.

Preferred Trap and Lure

Jackson trap with Cue-lure or Multilure® or McPhail trap with torula yeast

Zeugodacus tau

Zeugodacus tau originated in parts of Asia and is predominately a pest of cucurbits (melon, squash, etc.) but also attacks solanaceous plants (pepper, eggplant, etc.) and other fruits and vegetables.

Source: Pest and Disease Image Library 5490175 http://www.bugwood.org

Figure 4-18 *Zeugodacus tau*

Diagnosis and General Biology

Zeugodacus tau is reddish-black with three pale whitish to yellow stripes, a yellow abdomen has a distinctive black “T” pattern, and wings have enlarged black marginal spots. The wing has **no** brown spots along interior veins.

The pre-ovipositional period for *Z. tau* averages 10 days. An average of 16 eggs are laid per day. Larvae burrow and feed under the skin of the fruit, then exit through a hole to pupate underground. Eggs develop to adults in an average of 14 days. Female adults develop for an average of 11 days before beginning to mate. Adult males survive up to 121 days and females up to 191 days.

Distribution

Zeugodacus tau is widespread in tropical Asia: Bangladesh, Bhutan, Brunei, Cambodia, China, India (mainland, Andaman Group), Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan,

Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam. It has been detected on isolated occasions in California. The 2023 incursion in California was eradicated.

Preferred Trap and Lure

Jackson trap with Cue-lure, Multilure, or McPhail trap with torula yeast.

Appendix

A

Examples and Instructions for Completing and Issuing Forms

Contents

Introduction A-1
Trapping Section Map A-2
Property Survey Record Form A-3

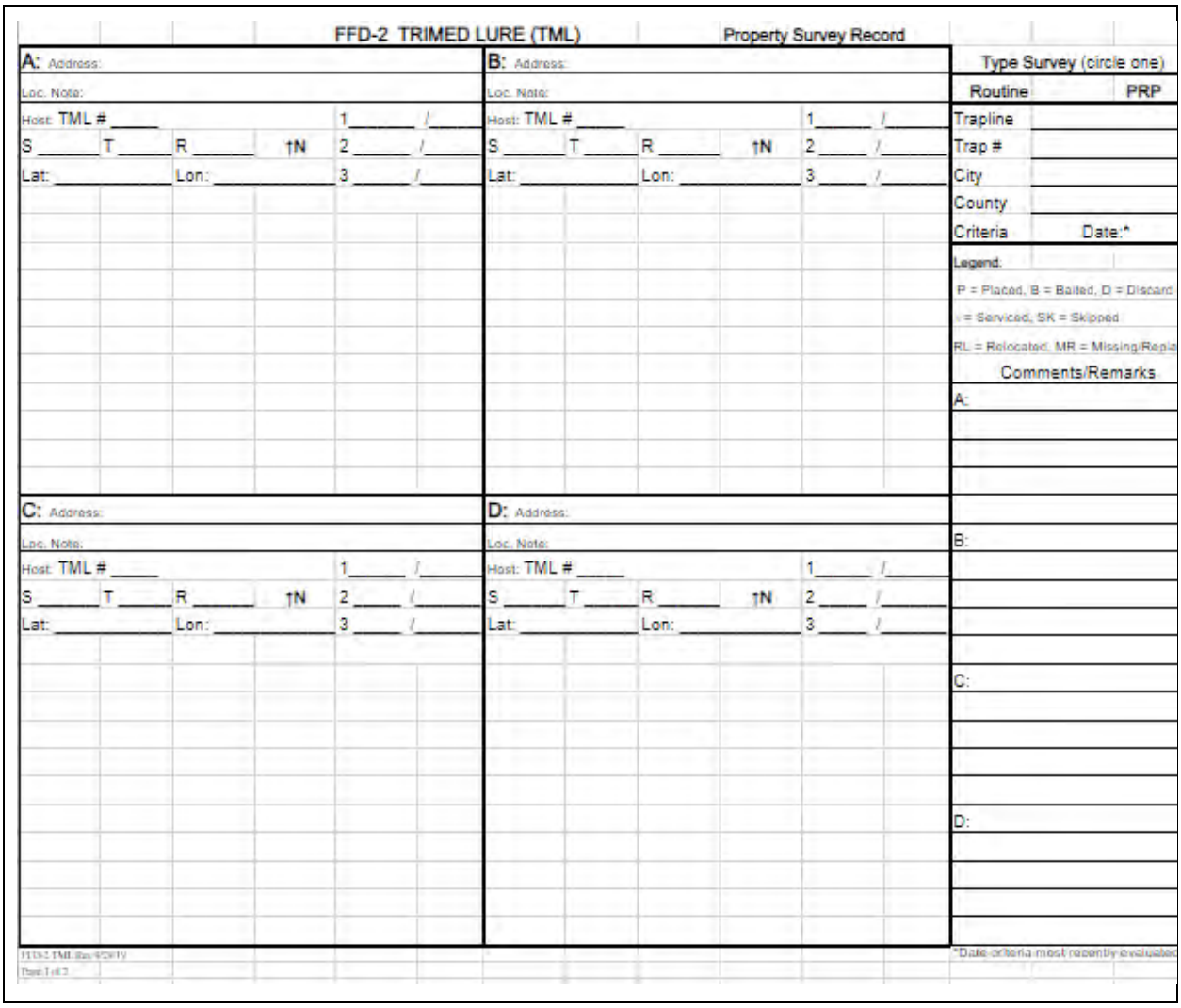
Introduction

This Appendix covers forms related to the Fruit Fly Exclusion and Detection Program. Refer to the Office of Operations Material Management Service Center website for ordering information. Forms are also available on the APHIS Electronic Forms Library website.

Trapping Section Map

Figure A-1 Example of Trapping Section Map

Property Survey Record Form



FFD-2 TRIMED LURE (TML) Property Survey Record

A: Address:	B: Address:	Type Survey (circle one)
Loc. Note:	Loc. Note:	Routine PRP
Host: TML # ____ 1____ /____	Host: TML # ____ 1____ /____	Trapline
S ____ T ____ R ____ †N 2____ /____	S ____ T ____ R ____ †N 2____ /____	Trap #
Lat: ____ Lon: ____ 3____ /____	Lat: ____ Lon: ____ 3____ /____	City
		County
		Criteria Date:*
		Legend:
		P = Placed, B = Baited, D = Discard
		= Serviced, SK = Skipped
		RL = Relocated, MR = Missing/Repla
		Comments/Remarks
		A:
C: Address:	D: Address:	
Loc. Note:	Loc. Note:	B:
Host: TML # ____ 1____ /____	Host: TML # ____ 1____ /____	
S ____ T ____ R ____ †N 2____ /____	S ____ T ____ R ____ †N 2____ /____	
Lat: ____ Lon: ____ 3____ /____	Lat: ____ Lon: ____ 3____ /____	
		C:
		D:
		*Date criteria most recently evaluated

Figure A-2 Example of Property Survey Record Form (Front)

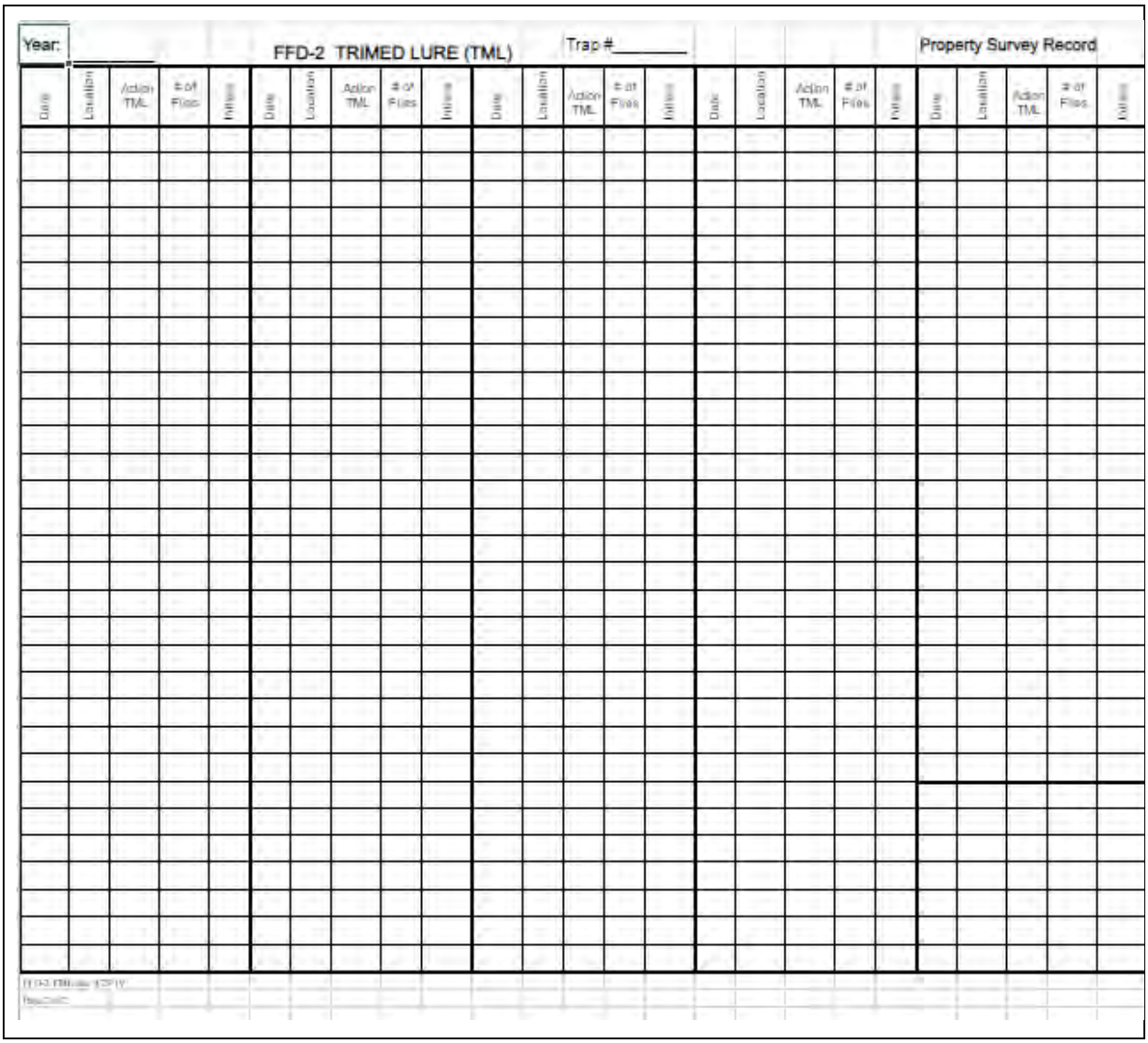


Figure A-3 Example of Property Survey Record Form (Back)