Fruit Fly Pests of Citrus

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Pest Introduction Risk

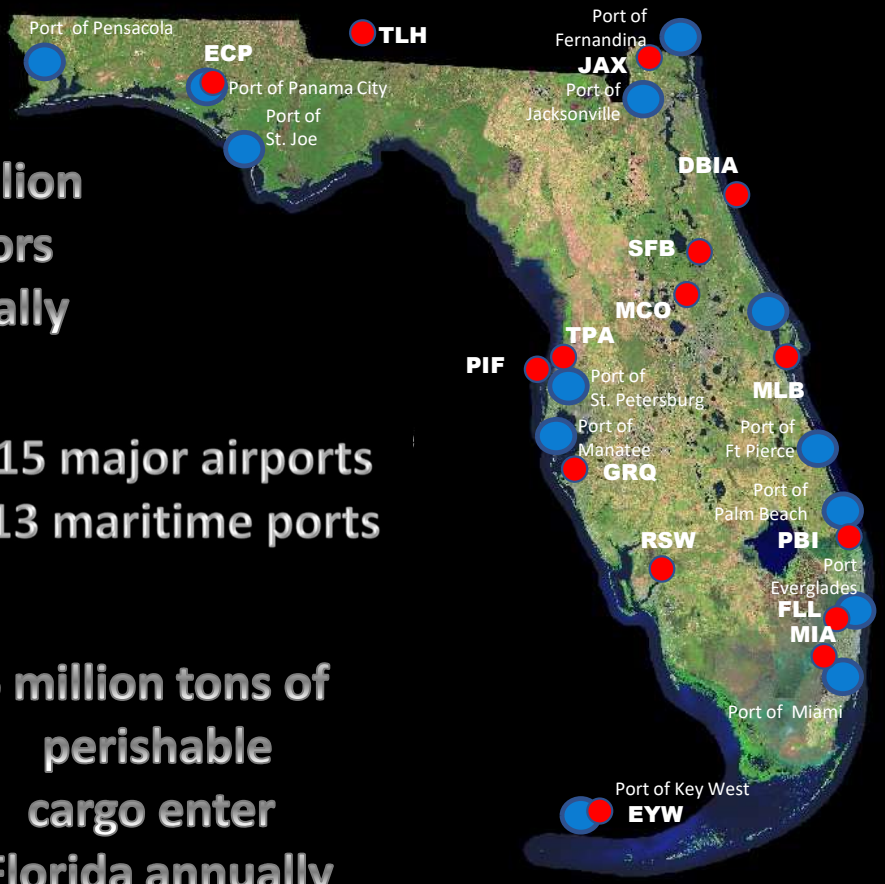
California and Florida are #1 and #2 respectively in invasive pest and disease introduction risk (USDA)

South Florida (Miami-Dade County) is ground zero for US introductions

Over two new exotic insects or pathogens reported by FDACS/DPI per month

confiscated ag items from Miami International Airport

Florida under siege



50 million visitors annually

15 major airports

13 maritime ports

6 million tons of perishable cargo enter Florida annually

Geographic location

Unique climate

Crop diversity

Increased trade

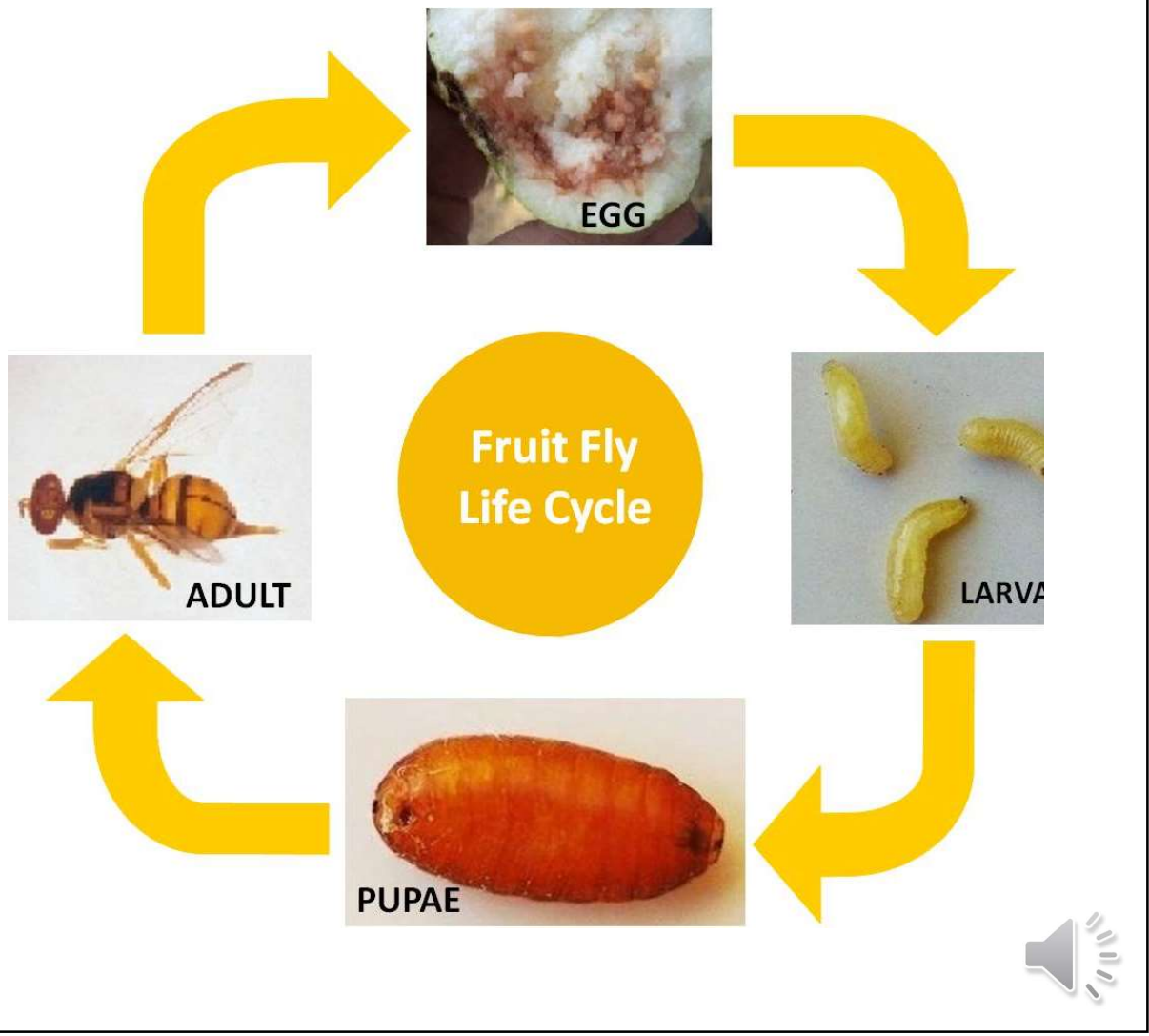
85% of plants imported into US go through Miami

Fruit flies (Diptera: Tephritidae)

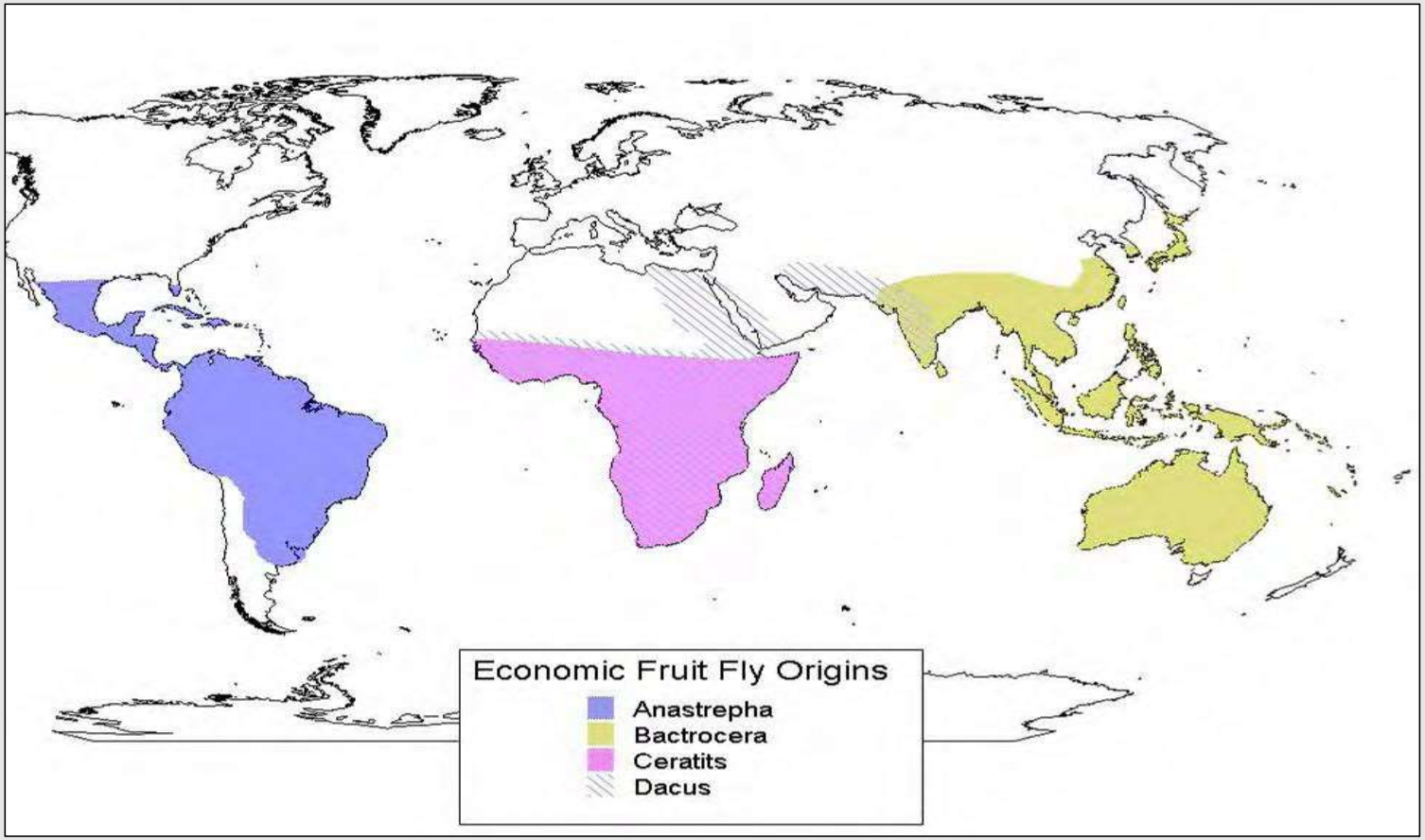
- Serious pests of citrus worldwide
- Adults lay eggs in fruits in which immatures (maggots) feed, leaving the fruit unfit
- Flies easily spread through movement of infested fruits and vegetables

Life History

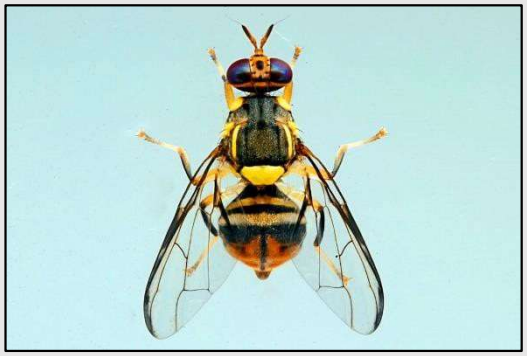
- Eggs are laid into or under the skin of citrus fruit
- Development is temperature driven
- Eggs hatch in 1-3 days
- Larvae feed for 1-2 weeks then exit the fruit to pupate in soil
- Adults emerge from pupae in 1-2 weeks
- Adult females require 1-2 weeks to become sexually mature



Origins of Economic Fruit Flies

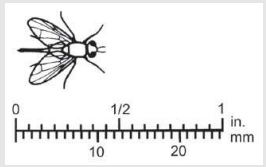


Fruit Fly Species of Concern



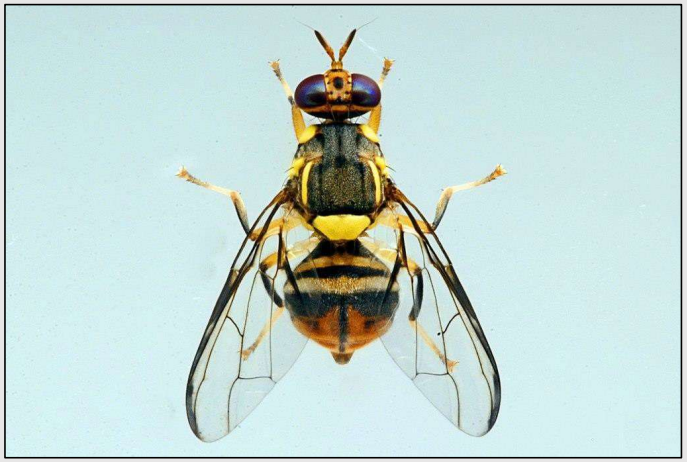
Mexican Fruit Fly

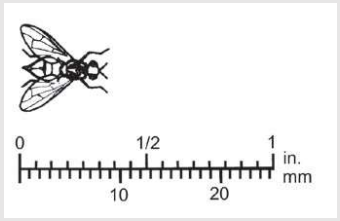
- *Anastrepha ludens* (Loew) 'Mexfly' is the most serious fruit fly pest in Mexico.
- Hosts: Major pest of citrus, mango and peach.
- Distribution: Lower Rio Grande Valley of Texas south through Mexico.
- Biology: Relatively large flies, very long-lived.
- No artificial sex attractants available for detecting mexfly.



Oriental Fruit Fly

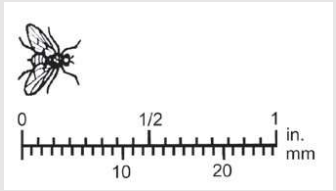
- *Bactrocera dorsalis* (Hendel)
- Hosts: Over 400 host plants have been listed.
- Distribution: Common from southern China to northern India; in Hawaii since 1945 and Guam since 1947.
- Biology: breeds continuously in tropical conditions. Females can produce 1,200-1,500 eggs in their lifetime.
- Young males are very strongly attracted to and actively imbibe methyl eugenol.





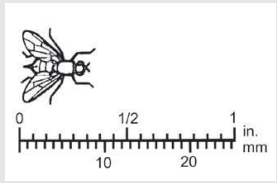
Mediterranean Fruit Fly

- *Ceratitis capitata* (Wiedemann)
- Widespread, destructive fruit pest, attacks over 250 species of plants.
- ‘Medfly’ is considered the most serious of the world’s fruit fly pests.
- Biology: Females are capable of producing 300-800+ eggs in their lifetime.
- Males are attracted to Trimedlure, a synthetic sex attractant.



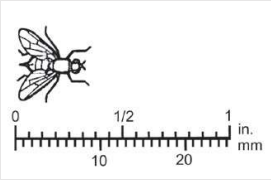
Melon Fly

- *Bactrocera cucurbitae* (Coquillett)
- Melon fly is the most destructive pest of melons and squashes in the Indo-Malayan region. Also a pest of citrus, particularly oranges
- Hosts: Major cucurbit crops.
- Distribution: Widespread in India, throughout southeast Asia, China and other tropical areas.
- Biology: Development time as little as 2 weeks. Adult lifespan 1-5 months, females may lay 300-1,000 eggs.
- Sexually mature males are strongly attracted to Cuelure (synthetic sex attractant).



Caribbean Fruit Fly

- *Anastrepha suspensa* (Loew)
- Currently established in Florida (1965)
- Found in over 30 counties in central and south Florida
- Relatively minor pest compared to other Tephritid fruit fly species
- Impact commercial fresh fruit exporters and residential growers



Protecting Florida from Exotic Fruit Flies

- Caribbean Fruit Fly Certification Program
- Preventative Release Program
- Widespread detection trapping
- Delimitation surveys/Eradication programs

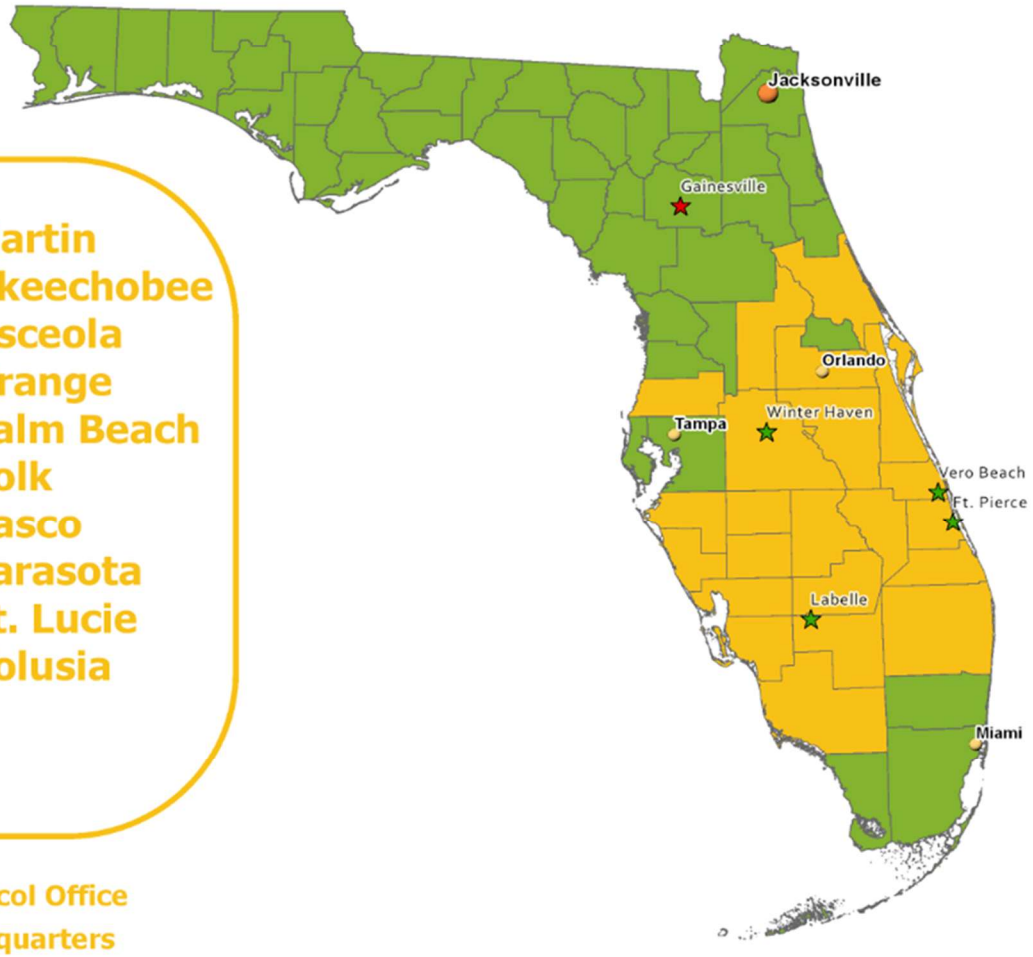
Methods Development

Caribbean Fruit Fly Protocol Program (CFFPP)

- Started in 1980's as means to certify citrus fruit as Carib fly free using a combination of survey, trapping and spray applications followed up by inspection and compliance activities in the packinghouse.
- Also requires removal of preferred hosts throughout the off season (loquat, Surinam cherry, etc.)
- Facilitate the export of fresh citrus to areas requiring regulatory safeguards including Japan, Korea, Philippines, Thailand, New Zealand, California, Hawaii and Texas.
- Peach and Carambola Protocols also established.

COUNTIES PARTICIPATING IN CARIBFLY PROTOCOL

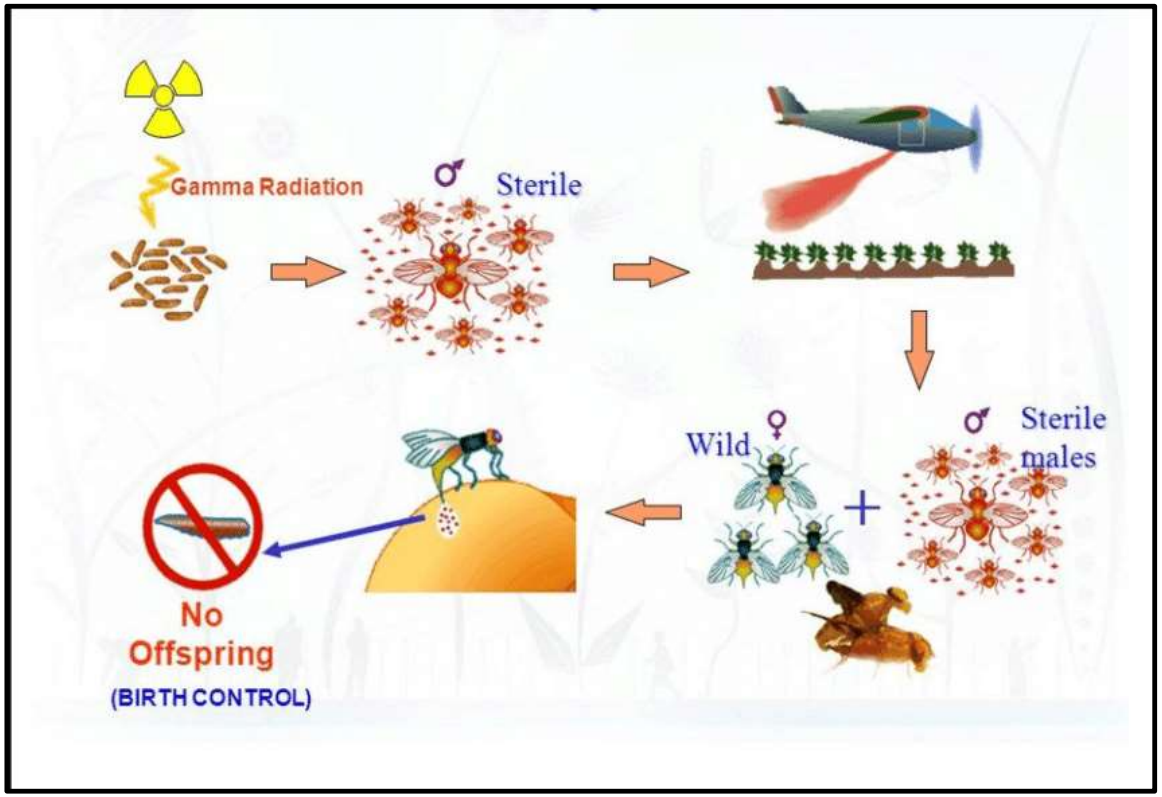
Brevard
Charlotte
Collier
DeSoto
Glades
Hardee
Hendry
Highlands
Indian River
Lake
Lee
Manatee
Martin
Okeechobee
Osceola
Orange
Palm Beach
Polk
Pasco
Sarasota
St. Lucie
Volusia



★ Caribfly Protocol Office
★ Division Headquarters

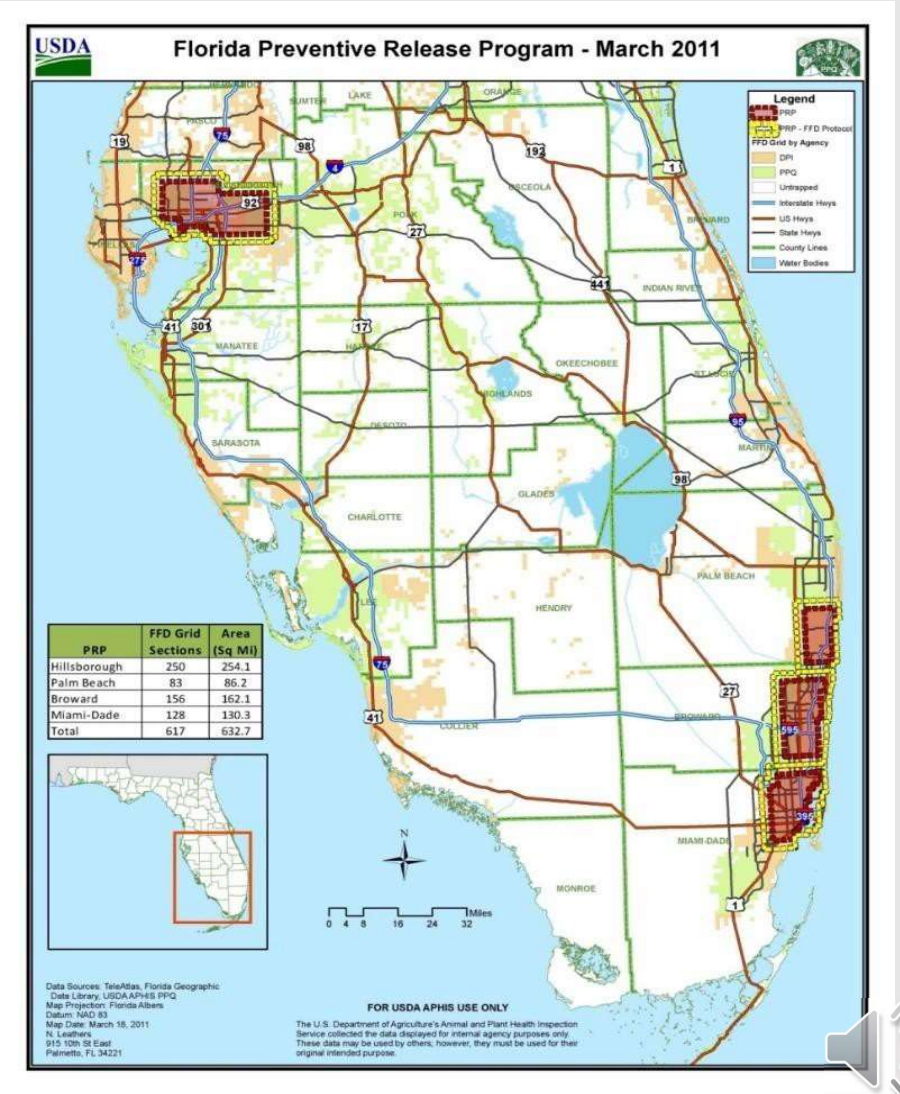
Preventative Release Program - Sterile Insect Technique

- The sterile insect technique is a biologically-based reproduction control method.
- Fly pupae are irradiated (made sterile) and released as adults to breed with wild flies, resulting in no offspring.



Preventative Release Program (PRP)

- Hillsborough, Palm Beach, Broward, Miami-Dade
- No pesticide - safe for the public
- No adverse impact on environment
- Biologically based
- Species specific
- Cost effective method
  - -Prevention
  - -Suppression
  - -Eradication



Aerial Release - Florida PRP

- Approximately 100 million flies released per week by USDA APHIS
- PRP covers over 600 hundred square miles throughout high-risk areas of the state.

Fruit Fly Detection Trapping

- Much of peninsular Florida is monitored year-round with an array of traps
- Approximately 56,000 traps are deployed over 8,000 square miles
- Traps are serviced every 7-21 days
- Multiple traps and lures: female-biased protein based torula yeast (glass McPhail), three component lures (multi-lure), or male –targeted parapheromone (Jackson)

Glass McPhail trap

Multi-Lure trap

Jackson trap

Fruit Fly Detection and Eradication History

Began with Med fly (*C. capita*) in 1929 – first successful large-scale eradication of tephritid fruit fly in history

70 detections since 1929
-Detections through statewide trapping only

Twenty-three eradication programs to date

$65.3 million to date on eradication

Successfully eradicated:
Caribbean FF * eradicated twice, established after 3rd eradication attempt
Carambola FF
Guava FF
Mediterranean FF
Mexican FF
Oriental FF
West Indian FF

1994	*dorsalis*	Ft. Lauderdale	Broward	1	0	0	$100,000	4
1995	*dorsalis*	St. Petersburg	Pinellas	3	0	0	$530,000	3*
1999	*dorsalis*	Tampa	Hillsborough	12	4	0	$100,000	3*
1999	*dorsalis*	Deltona	Volusia	1	0	0	N/A	3
1999	*correcta*	Titusville	Brevard	2	0	0	N/A	3
2000	*dorsalis*	Bradenton	Manatee	1	0	0	N/A	3
2001	*correcta*	Apopka	Orange	1	0	0	N/A	3
2001	*correcta*	Oviedo	Seminole	1	0	0	N/A	3
2001	*dorsalis*	Kissimmee	Osceola	1	0	0	N/A	3
2001	*dorsalis*	Sarasota	Sarasota	2	0	0	$100,000	3*
2002	*correcta*	Homestead	Miami-Dade	1	0	0	N/A	3
2002	*correcta*	Pinellas Park	Pinellas	3	0	0	N/A	3
2002	*correcta*	Miami	Miami-Dade	1	0	0	N/A	3
2002	*correcta*	Apopka	Orange	1	0	0	N/A	3
2002	*dorsalis*	Orlando	Orange	2	0	0	N/A	3
2002	*dorsalis*	Pompano Beach	Broward	1	0	0	N/A	3
2007	*dorsalis*	Valrico	Hillsborough	1	0	0	N/A	3
2007	*dorsalis*	Orlando	Orange	1	0	0	N/A	3
2007	*dorsalis*	Orlando	Orange	1	0	0	N/A	3
2008	*correcta*	Orlando	Orange	1	0	0	N/A	3
2008	*carambolae*	Orlando	Orange	2	0	0	N/A	3
2010	*dorsalis*	Safety Harbor	Pinellas	2	0	0	N/A	3
2010	*zonata*	Miami	Miami-Dade	1	0	0	N/A	5
2011	*correcta*	Windermere	Orange	1	0	0	N/A	4
2013	*correcta*	Sarasota	Sarasota	1	0	0	N/A	4
2014	*dorsalis*	Plantation	Broward	1	0	0	N/A	2
2015	*correcta*	Boynton Beach	Palm Beach	2	0	0	N/A	3
2015	*dorsalis*	Palmetto Bay, Redland, Miami	Miami-Dade	140	18	8	$3,500,000	6*
2016	*dorsalis*	St. Petersburg	Pinellas	1	0	0	N/A	2
2017	*dorsalis*	Mt. Dora	Lake	1	0	0	N/A	4
2017	*dorsalis*	Clearwater	Pinellas	1	0	0	N/A	3
2017	*dorsalis*	Weston	Broward	1	0	0	N/A	3
2017	*correcta*	St. Petersburg	Pinellas	1	0	0	N/A	4
2018	*zonata*	Lake Worth	Palm Beach	2	0	0	N/A	2
2018	*dorsalis*	Redland	Miami-Dade	4	0	0	$625,000	4*

Bactrocera spp. detections since 1994

Eradication Programs

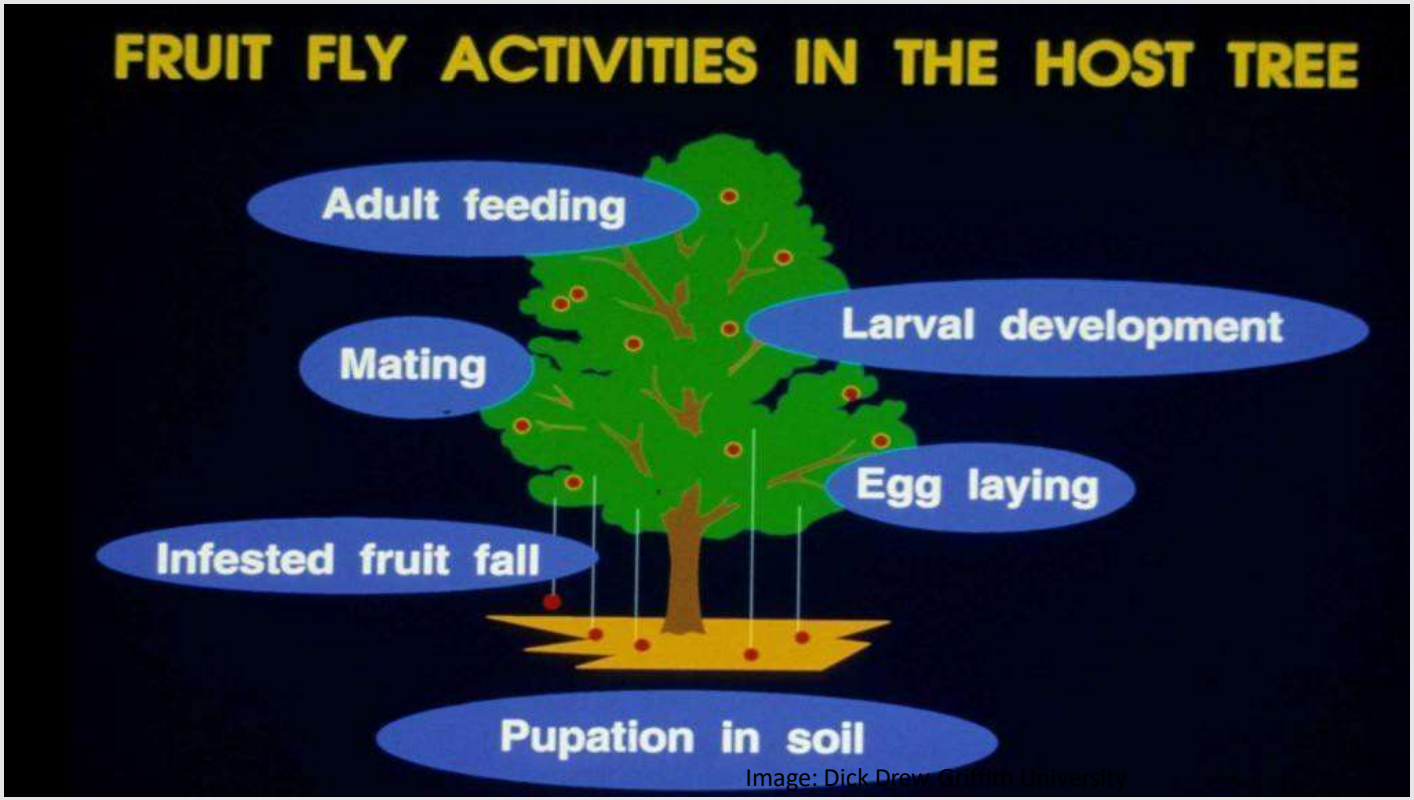


Image: Dick Drew, Griffith University

All life stages are targeted for elimination via:

- **Fruit Stripping**
- **Sprays and drenches**
- **Male Annihilation Technique**
- **Bait stations**

Fruit Stripping & Soil Drenching

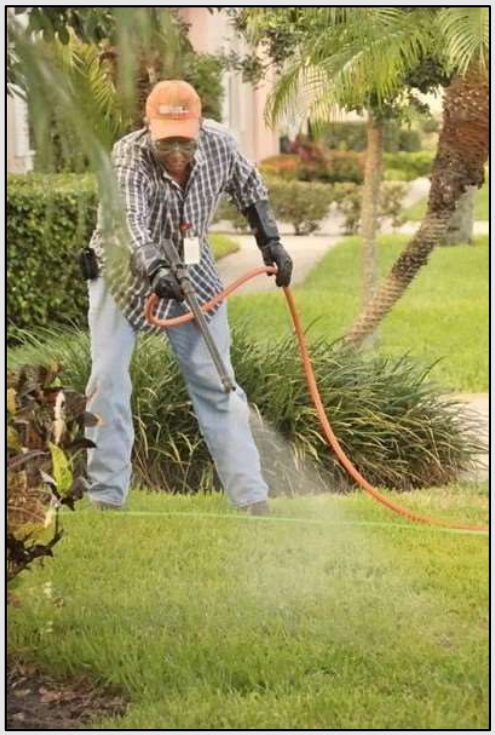
Remove all host fruit to break fly life cycle

Even fruit from high value crops can be legally stripped and destroyed!

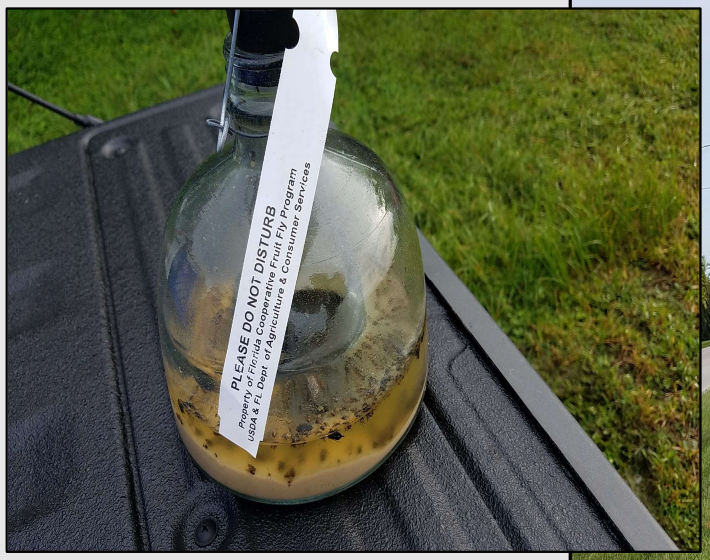
Fruit fly eradication programs rely on an effective soil drench to eliminate pupal infestations in the soil under host trees.

Soil Drench Alternatives

- More environmentally friendly alternatives to Diazinon were needed.
- Division of Plant Industry Methods staff investigated new pesticides.
- Warrior (Lambda-cyhalothrin) currently utilized on emergency fruit fly programs.
- Applied under the drip line of host plants to target third instar and pupae



Bait Stations



Male targeting Jackson traps with ME/Dibrom

Female biased McPhail traps baited with liquid protein bait torula yeast plus borax

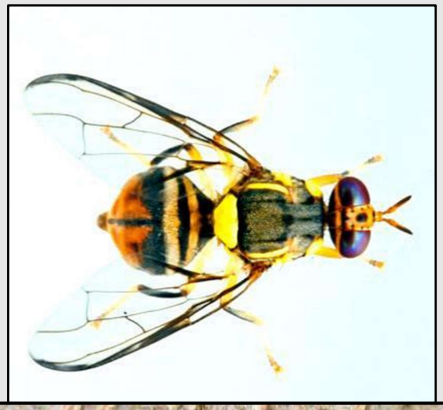
Fruit Fly Bait Cover Sprays

Spinosad/protein hydrolysate bait spray applied to underside of foliage of host and non-host trees and plants

Using a bait reduces total area requiring pesticide

GF-120 (Spinosad) is certified for use in organic production systems

Male Annihilation Technique (MAT)

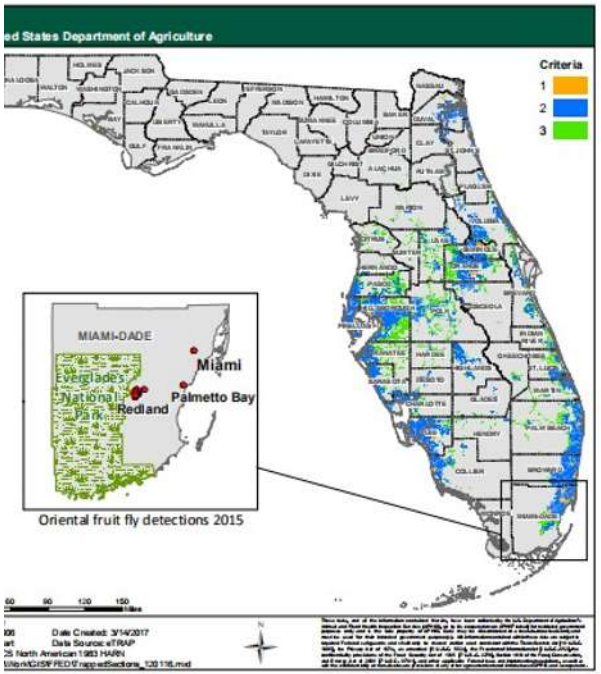


- *Bactrocera* spp.
- Dibrom Alternative Technology
- SPLAT-MAT ME™ is sprayable, numerous advantages over traps in terms of convenience, cost, and the number of attract-and-kill point sources (spots) per unit area.
- Spinosad and Methyl eugenol (male attractant)
- Low mammalian/environmental toxicity.

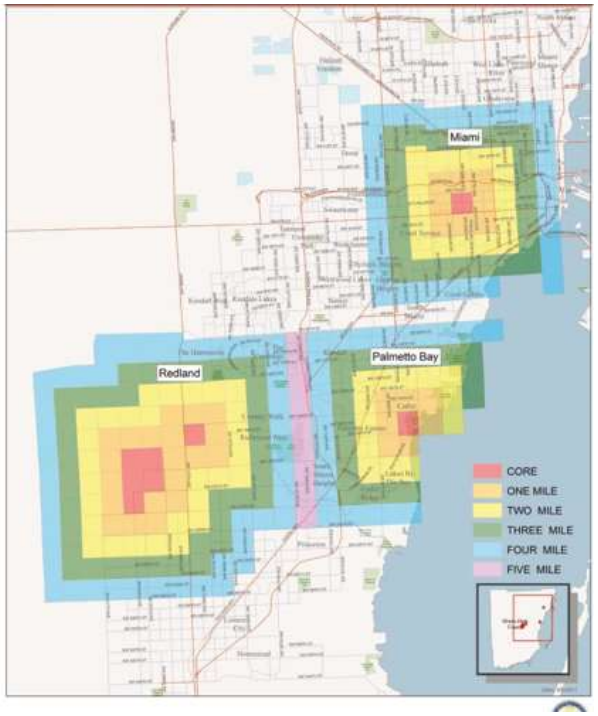
Male Annihilation Technique (MAT), cont'd

- Applied by hand or vehicle
- Used within a minimum 2.4 km radius around any fly detection site
- 600 spot treatments per 2.6 km² every 1-2 weeks

Oriental Fruit Fly Eradication in FL, 2015-16, (Steck et al. 2019)



detection trapping array in Florida. Trap densities based on risk criteria 1, 2, 3 (high, medium, and low, respectively).



- Largest OFF population ever discovered in Florida (Redlands- Miami Dade Co.)
- Occurred in the largest tropical fruit production area in the continental US resulting in 99-square mile quarantine
- Personnel (FDACS, USDA, UF) worked 7 days a week for 6 months in the “hot zone” to eradicate this pest.
- Approximately 450 state and federal personnel participated

Oriental Fruit Fly Eradication, cont'd (Steck et al. 2019)

Eradication cost: $3,500,000

Total of 1,804 compliance agreements issued to over 800 plant nurseries, over 800 growers and numerous packing houses

Over 100,000 kg of fruit from regulated hosts (over 400) was removed from the quarantine zone

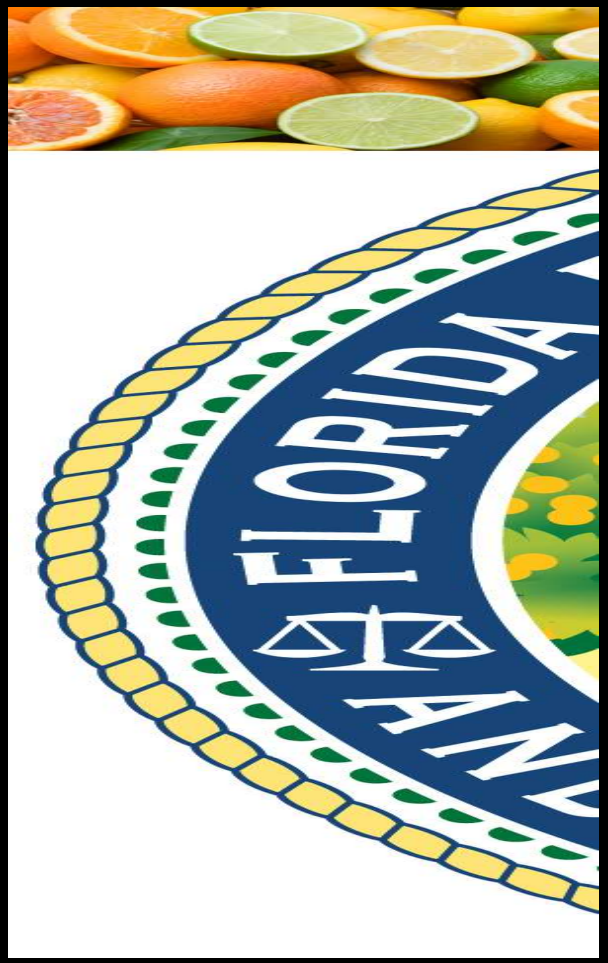
FDACS Agriculture Law Enforcement patrolled quarantine and confiscated 75,000 kilograms of non-compliant commodities being illegally moved

Program required tremendous amount of cooperation and resources:
Outreach
Control
Science
Technology
Regulatory

Methods Development

Continually testing new lures, traps, chemicals for incorporation into fruit fly programs statewide

Focus on efficacy, safety, cost



- Exotic fruit flies are considered some of the most serious of the world's agricultural pests due to their potential economic harm and threat to our food supply. They attack hundreds of different fruits, vegetables and nuts, including citrus, apples, guava, mango, tomatoes and peppers.

- FDACS-Division of Plant Industry remains dedicated to protecting Florida's citrus industry from exotic fruit flies through early detection and rapid response.