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

New Pest Response Guidelines

Anastrepha spp.

Caribbean fruit fly, *Anastrepha suspensa* (Source: Florida Division of Plant Industry, FDACS, Bugwood.org)

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Chapter 1

Introduction

Plant Protection and Quarantine (PPQ) develops New Pest Response Guidelines (NPRGs) in preparation for potential pest introductions. This document is based on the best information available at the time of development and may not reflect the latest state of knowledge at the time the pest is detected. In addition, PPQ's response must be tailored to the specific circumstances of each pest introduction event, which cannot be predicted. Therefore, this document provides only general guidelines that can be used as a basis for developing a situation-specific response plan at the time a new pest is detected.

Program managers of Federal emergency response or domestic pest control programs must ensure that their programs comply with all Federal Acts and Executive Orders pertaining to the environment, as applicable. Refer to the Environmental Compliance section in Appendix A for details.

This document is intended to cover all *Anastrepha* spp. excluding *A. ludens*. *Anastrepha ludens* is referenced in this document only for comparison purposes. For additional information about *A. ludens*, refer to the Mexican fruit fly program website. For more information about other fruit fly programs, refer to the USDA fruit fly exclusion and detection program website.

Chapter 2

Pest Overview

Key Information

- Fruit flies of the genus *Anastrepha* are among the most damaging endemic fruit flies in the Americas.
- *Anastrepha fraterculus*, *A. ludens, A. obliqua, A. serpentina,* and *A. striata* are widely distributed throughout Mexico and Central and South America. *Anastrepha grandis* is native to South America, and *A. suspensa* is found in the Caribbean and established in Florida.
- *Anastrepha* spp. are estimated to cause losses of 25-80% in various crops in Central and South America.
- *Anastrepha* spp. can have one or more generations per year. Adult populations peak when host fruiting peaks.
- *Anastrepha* spp. primarily spread as adults through flight or as larvae through movement of infested fruit.
- For the majority of *Anastrepha* spp., identification is morphological and based primarily on female ovipositor characteristics and wing patterns.
- Several insecticides offer close to 100% control; bait sprays containing malathion or spinosad insecticides are recommended for eradication.

Taxonomy

The genus *Anastrepha* has more than 300 recognized species belonging to 27 species groups (Norrbom, 2022; Norrbom et al., 2018; Rodriguez et al., 2022; Steck et al., 2019).

Taxonomic Position

- Arthropoda : Insecta : Diptera : Tephritidae

Distribution and Impact

Fruit flies of the genus *Anastrepha* are among the most damaging endemic fruit flies in the Americas (Aluja, 1994; Norrbom and Foote, 1989). *Anastrepha* spp. are major pests of commercially important fruit, such as mango, citrus, and guava (Baker et al., 1944). The genus has about a dozen economically important species (Aluja, 1994; Steck et al., 2019; White and Elson-Harris, 1992); these species cause losses in Central and South America of 25 to 80% on average (Enkerlin et al., 1989; Soto-Manitiu et al., 1987; Gonzalez et al, 2002, cited by Pérez Chávez et al., 2008).

Among the economically important species, *A. fraterculus*, *A. striata*, *A. serpentina*, *A. obliqua* and *A. distincta* are distributed throughout Mexico and Central and South America (Norrbom and Foote, 1989; Steck et al., 1990). *Anastrepha ludens* is distributed primarily in Mexico and areas of higher elevations in Central America (Norrbom and Foote, 1989). *Anastrepha grandis* is native to South America (Silva and Malavasi, 1993), and *A. suspensa* is native to the Caribbean and established in Florida (Enkerlin et al., 1989; Greany and Riherd, 1993). *Anastrepha curvicauda* is present in Mexico, the United States (Florida and Texas), and Central and South America (Norrbom et al., 2018).

Biology and Ecology

Life Cycle

The general life cycle and basic biology of *Anastrepha* fruit flies are similar among species (Aluja, 1994; Aluja et al., 2001; Christenson and Foote, 1960). However, developmental times vary and depend on the fly species, host and environmental conditions (Baker et al., 1944). Lower temperatures and less favorable hosts prolong developmental time among several species (Aluja, 1994; Leyva et al., 1991; Bolzan et al., 2017; Telles-Romero et al., 2011; Bolzan et al., 2015). *Anastrepha* spp. have one or more generations per year (Aluja, 1994; dos Santos et al., 2017; Weems et al., 2012a; Garcia et al., 2003). Adult populations peak when host fruiting peaks (Celedonio-Hurtado et al., 1995; Soto-Manitiu and Jirón, 1989; dos Santos et al., 2017; Ronchi-Teles and Da Silva, 2005; Hedström, 1991). Diapause has not been reported in any *Anastrepha* spp. (Aluja et al., 2001).

Eggs

Most *Anastrepha* spp. lay eggs in mature or ripe fruit (Aluja et al., 2003; Baker et al., 1944; Malavasi et al., 1983; Weems, 1969). Eggs are typically inserted in fruit skin or pulp, but some species, such as *A. hamata*, deposit eggs inside developing seeds (Aluja et al., 2001). Eggs can be laid singly (e.g., *A. obliqua*) or in clutches of up to 110 eggs (e.g., *A. grandis*), with clutch size dependent on fly species and fruit size/ripeness (Aluja et al., 2014; Aluja et al., 2001; Leyva et al., 1991). Females may produce hundreds of eggs during their lifetime (Bisognin et al., 2015; Bolzan et al., 2015); for example, *A. ludens* has laid up to 1,400 eggs under laboratory conditions (Carey et al., 2005). Under favorable temperatures (73ºF–82ºF), *Anastrepha* eggs hatch in 2–9 days (Leyva et al., 1991; Bolzan et al., 2017; Dias and Lucky, 2017; Celedonio-Hurtado et al., 1988).

Larvae

Larvae develop inside fruit, consuming pulp and/or seeds (Aluja et al., 2001; Morgante et al., 1996; Plummer et al., 1941). They typically exit the fruit after it has fallen to the ground to pupate in soil, but some larvae may exit while the fruit is still on the tree (Aluja et al., 2001). The larval period generally lasts between 2–4 weeks (Leyva et al., 1991; Weems et al., 2012b; Celedonio-Hurtado et al., 1988; Weems, 1965; Dias and Lucky, 2017; Lawrence, 1979; Bolzan et al., 2017).

Pupae

Pupation typically occurs in soil at a depth of 1–2 inches (Aluja et al., 2001; Hodgson et al., 1998). Pupal development takes a variable amount of time depending on the species and temperature (Aluja et al., 2014; Bolzan et al., 2017; Telles-Romero et al., 2011). Some species may overwinter as pupae (McGrath et al., 2021; Thomas, 2003).

Adults

Adult fruit flies typically emerge during morning hours (Aluja, 1994; Aluja et al., 1993). After emergence, adults rest and feed on carbohydrate and protein sources (e.g., plant sap, rotting fruit, aphid honeydew) before becoming sexually mature (Aluja, 1994; Christenson and Foote, 1960). Females can reach sexual maturity within 7–20 days (Aluja et al., 2009; Dias et al., 2017; Dickens et al., 1982; Martínez et al., 1995). Males of most *Anastrepha* spp. aggregate in non-host trees to compete for females (lekking behavior) (Aluja, 1994; Aluja et al., 1993; Aluja et al., 2001). However, in at least one monophagous species (*A. bistrigata*), males patrol host fruit for mating opportunities (Morgante et al., 1993). Egg laying can begin shortly after mating (Thomas, 2003). Daily activities (e.g., resting, feeding, mating, and oviposition) occur in species-specific patterns, but the timing of these behaviors also varies according to environmental conditions, with adults generally resting among foliage during the hottest part of the day (Aluja, 1994; Aluja et al., 1993; Aluja et al., 2001; Malavasi et al., 1983). Longevity is highly variable among species (Aluja et al., 2001), but *A. ludens* adults have been recorded living for as long as 12 months in the field (Shaw et al., 1967).

Hosts

The Global Pest and Disease Database (GPDD) provides host lists of various fruit fly species. Host lists of the following *Anastrepha* spp. are available at the links below.

- *Anastrepha curvicauda*
- *Anastrepha distincta*
- *Anastrepha fraterculus*
- *Anastrepha grandis*
- *Anastrepha ludens*
- *Anastrepha obliqua*
- *Anastrepha serpentina*
- *Anastrepha striata*
- *Anastrepha suspensa*

Dispersal

Human-Assisted Spread

Human-assisted spread of *Anastrepha* spp. primarily occurs by the transport of infested fruit through trade or travel (Weems, 1965; EFSA, 2021; USDA-APHIS-PPQ, 2001). Pupae in soil or packaging of fruit-bearing trees can also transport the pest to new areas (USDA-APHIS-PPQ, 2001).

Natural Dispersal

Members of the genus *Anastrepha* have varying dispersal capabilities. Prevailing winds aid *Anastrepha* dispersal and orientation (Baker and Chan, 1991; Baker et al., 1986). *Anastrepha ludens* can fly up to 23 miles within a year, but typically flies between 3 and 5 miles (Shaw et al., 1967), with a short-range dispersal of 0.15 miles (Thomas and Loera-Gallardo, 1998). Similarly, *A. obliqua*, *A. fraterculus*, and *A. suspensa* have a general short-range dispersal of less than 0.2 miles (Hernández et al., 2007; Kendra et al., 2010; Kovaleski et al., 1999). The maximum reported dispersal range for *A. fraterculus* and *A. obliqua* is 0.6 miles within 3–5 weeks (Kovaleski et al., 1999; Soto-Manitiu and Jirón, 1989).

Chapter

3

Pest Identification

Species ID/Diagnostic

Morphological

Adults

Adult *Anastrepha* are predominantly yellowish-brown flies, slightly larger than a house fly, with a wingspan of 0.24–0.35 inches depending on the species. The genus *Anastrepha* differs from other fruit fly genera by wing venation characters, yellow and brown banding on the wings and body, and the shape and length of the ovipositor (Fig. 3-1) (Weems, 1965, 1969, 1982; Weems and Fasulo, 2006; Weems, 2001). Typically, most species have an inverted 'V'-shaped marking on the outer half of the wings (Figs. 3-2, 3-3) (Norrbom and Foote, 1989; Weems et al., 2012a; Weems et al., 2012b). Females are generally larger than males (Dias and Lucky, 2017; Sivinski and Dodson, 1992). Identification to the species level is based primarily on adult female ovipositor characteristics and wing venation and banding (Dias and Lucky, 2017; Weems, 1963; Weems, 1965, 1982; Weems, 1969, 2001; Norrbom et al., 2019; White and Elson-Harris, 1992).

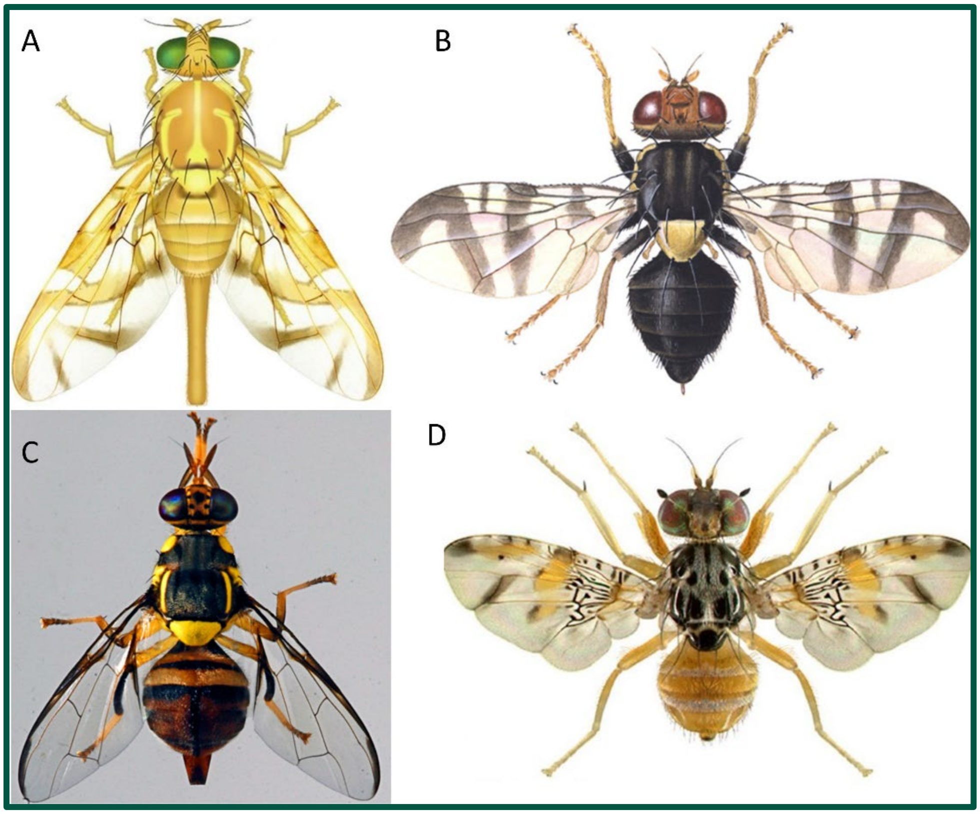

Figure 3-1 General appearance of four fruit fly genera; A. *Anastrepha ludens;* B. *Rhagoletis cerasi*; C. *Bactrocera dorsalis;* D. *Ceratitis capitata.* Note the differences in the wing banding among major genera (Source: Taina Litwak, USDA-ARS, Bugwood.org; Arthur D. Cushman, USDA; IAEA imagebank; G. Georgen, IITA).

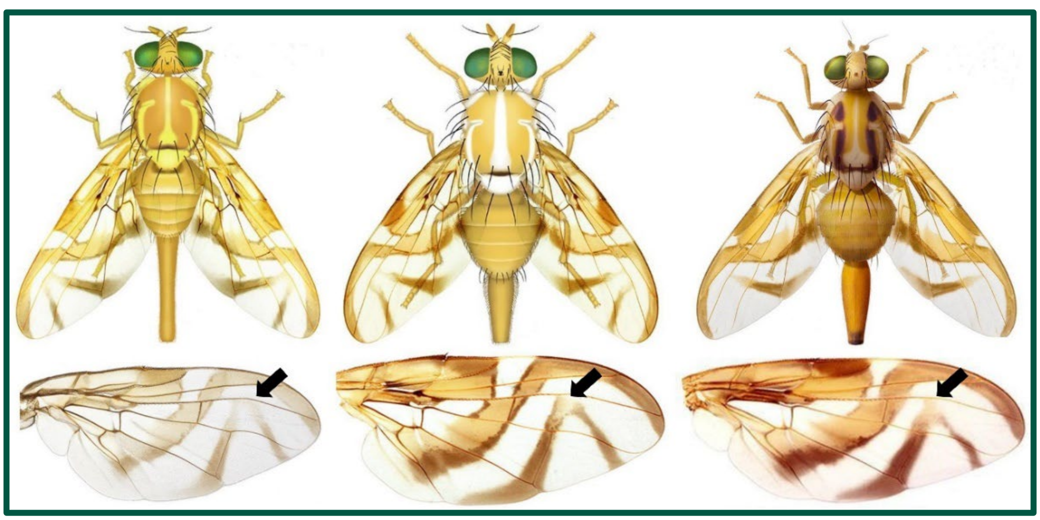

Figure 3-2 Adult female and wing venation of *A. ludens, A. fraterculus, and A. striata*. The inverted 'V-shaped' marking on the wing is indicated with an arrow (Source: Taina Litwak, USDA-ARS; A. Norrbom et al., USDA-APHIS-PPQ, Bugwood.org).

Figure 3-3 Adult female and wing venation of *A. grandis, A. serpentina, A. suspensa,* and *A. obliqua.* The inverted 'V-shaped' marking on the wing, when visible, is indicated with an arrow (Source: Taina Litwak, USDA–ARS, A. Norrbom et al., USDA–APHIS–PPQ, Bugwood.org).

Eggs

Eggs of *Anastrepha* spp. are very small, white and spindle-shaped, wider towards the front and tapering towards the rear (Fig. 3-4) (Emmart, 1933; Lawrence, 1979; Selivon and Perondini, 1999).

Figure 3-4 Eggs of *Anastrepha* spp., (top to bottom): *A. ludens*, *A. serpentina,* and *A. obliqua* (Source: A. Norrbom et al., USDA–APHIS–PPQ, Bugwood.org)

Larvae

Larvae are typically cylindrical and pale yellow and have a pair of well-developed mouth hooks (Fig. 3-5). Third instar larvae are usually 0.35–0.47 inches in length. Identification of several *Anastrepha* spp. by larval features is possible using scanning electron microscopy (Weems, 2001; Steck et al., 1990; Dutra et al., 2018a; Dutra et al., 2018b; Rodriguez et al., 2022; Rodriguez et al., 2021).

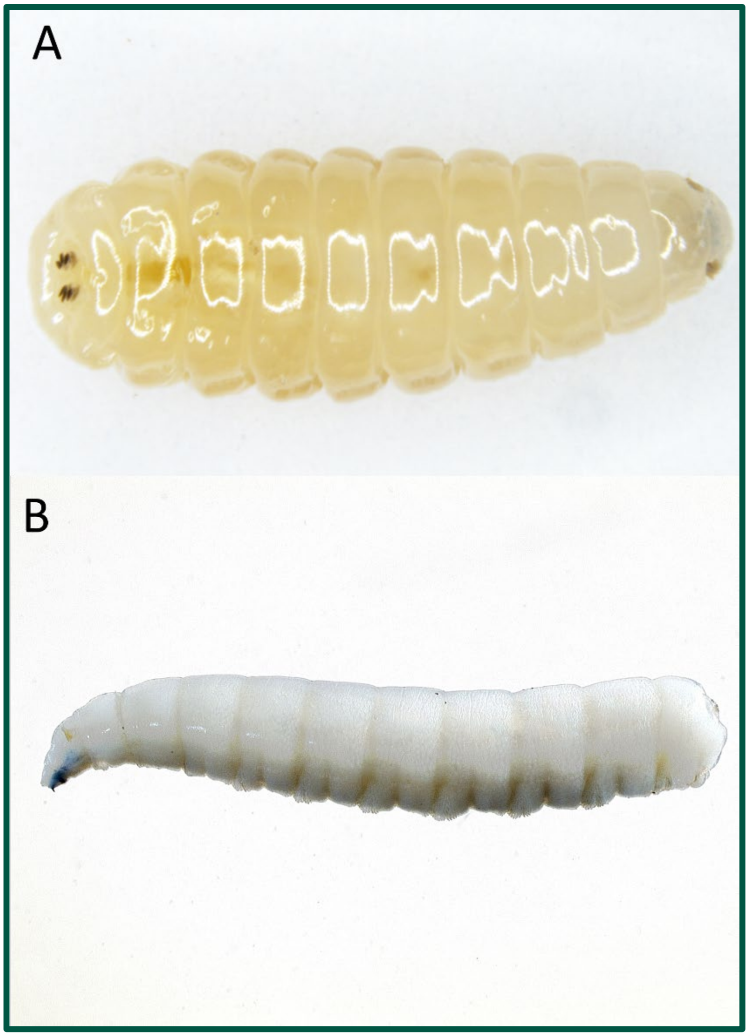

Figure 3-5 A. Larva of *Anastrepha* sp.; B. Lateral view showing the mouth hook (Sources: Pedro Rendon, USDA–APHIS; Gary Steck, Florida Division of Plant Industry)

Pupae

Pupae are brown and cylindrical, measuring about 0.15–0.31 inches in length and up to 0.11 inches in diameter depending upon the species (Greene, 1929).

Molecular

Molecular identification of some *Anastrepha* spp. can be done through DNA sequencing of the COI gene (Barr et al., 2018) or a portion of the ITS2 gene (Barr et al., 2017).

Signs and Symptoms

External signs of fruit fly infestation include oviposition punctures, but these may be difficult to detect during early infestation (EFSA, 2021). The most obvious sign of infestation is the presence of larvae inside the fruit and exit holes on the fruit (Fig. 3-6). *Anastrepha ludens* infestation may change the color of grapefruit (Baker et al., 1944).

Figure 3-6 *Anastrepha suspensa* larvae in citrus fruit (Source: Florida Division of Plant Industry)

Chapter 4

Delimitation Survey

Introduction

Delimitation surveys are used to determine the extent of the infested area after a detection has been confirmed. The criteria for initiating a delimitation survey are determined by the specific response triggers for *Anastrepha* spp. developed by USDA-APHIS Fruit Fly Exclusion and Detection Program (see Emergency Response Triggers). Refer to the USDA-APHIS Fruit Fly Exclusion and Detection Program Website for updated information regarding quarantine information, program updates and reviews, and additional resources.

Delimitation Area

The standard delimitation area for *Anastrepha* spp. is a 9 x 9-mile square grid (81 square miles) around the initial detection. The delimitation area will be expanded if there are additional detections within the original 9 x 9-mile delimitation area (USDA-APHIS, 2015b).

Survey Considerations

Surveyors will need to consider the potential challenges when adjusting this survey to fit highly developed urban or residential landscapes with few suitable or accessible trapping sites. Optimize the likelihood of capture by placing traps within or around host plants or in green areas near high-risk introduction points. High-risk areas will often include airports, warehouses, nurseries, or other sites that are likely to move high volumes of fresh produce and other products that can carry pests. Surveying around these high-risk areas will require on the ground assessments for access and site suitability as well as permissions from property owners to place and maintain traps.

Emergency Response Triggers

Anastrepha spp. are regulated pests, and their detection will trigger delimitation, quarantine, and/or eradication responses. The triggers for emergency response activities in the event of an *Anastrepha* spp. detection are given in Table 4-1.

Table 4-1 Cooperative fruit fly emergency response triggers for *Anastrepha* spp. (USDA-APHIS, 2020)

Pest Species	Trigger for Delimitation	Duration of Delimitation	Trigger for Eradication	Trigger for Quarantine
Anastrepha spp.	1 fly	3 generations	2 flies within a 3-mile radius during 1 life cycle	2–5 flies (based on risk assessment) within a 3-mile radius during 1 life cycle
Mated female of any genus and species of fruit fly presumed or known to be mated to a wild male; a larva or pupa	1 mated female or immature stage	3 generations	1 mated female or immature stage	1 mated female or immature stage

Timing of Surveys

Start delimitation surveys immediately after detecting a single wild fly, mated female, or immature stages of any *Anastrepha* spp. (see Emergency Response Triggers). A buffer area around the site should be established within 72 hours following confirmation of the initial detection. Delimitation surveys should continue for at least three life cycles based on the degree day requirements of the detected *Anastrepha* spp. (USDA-APHIS, 2020).

Survey Techniques for Delimitation

Trapping

Trapping using Multilure traps or McPhail traps is the primary method for detection and delimitation of adult *Anastrepha* spp. Multilure traps are baited with the two-component (2C) lure of ammonium acetate and putrescine. When McPhail traps are used, bait with torula yeast pellets or a liquid mixture of Nu-Lure, borax, and water (USDA-APHIS, 2015a, 2015b). Refer to the National Exotic Fruit Fly Detection Trapping Guidelines for detailed instructions on the preparation of attractant bait mixtures and trap setup.

Trap Density

The recommended delimitation survey design for *Anastrepha* spp. consists of a 1 square mile core area around the initial detection, surrounded by four concentric buffer areas comprising a total of 81 square miles (Fig. 4-1). Place traps in the core and four buffer areas with an 80-40-20-10-5 array of traps per square mile (Table 4-2) (USDA-APHIS, 2015b).

Trap Placement

Whenever possible, traps should be placed on host trees (see Hosts), in the upper two-thirds of the canopy (Fig. 4-2a). Prioritize host trees with mature or ripe fruits when placing traps. Hang traps near ripe or ripening fruits and foliage, but do not place in dense foliage that may block the trap entrance (Fig 4-2b). Hang traps high enough so that they are out of reach (Fig. 4-2c). Distribute traps evenly based on the host tree distribution (USDA-APHIS, 2015a).

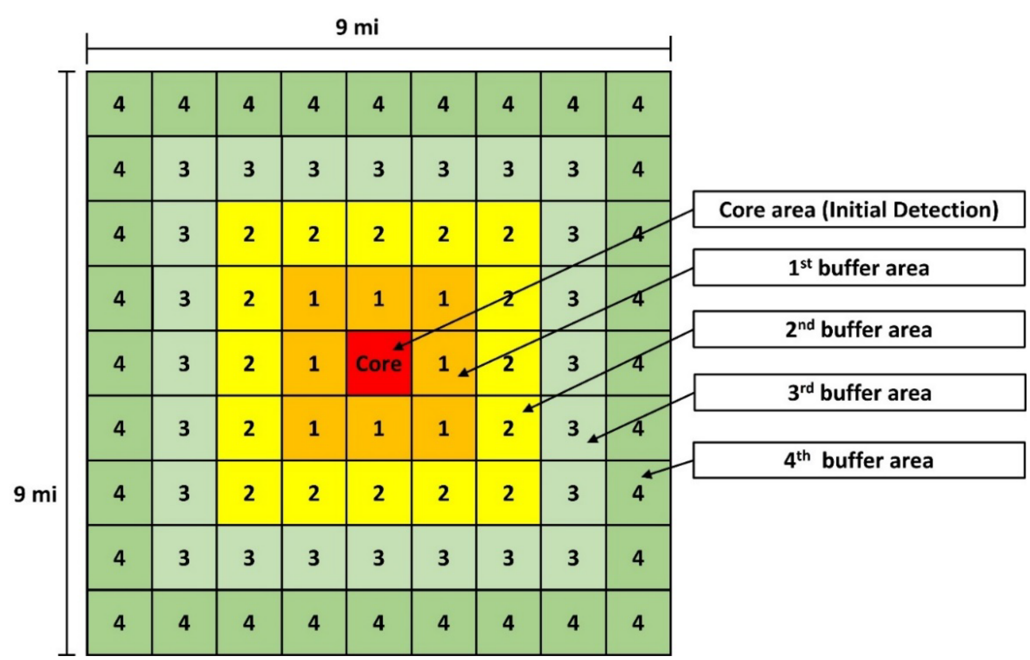

Figure 4-1 Standard 9 x 9 square mile delimitation area for *Anastrepha* spp. with a designated core and four concentric buffer areas

Table 4-2 Details of area and total traps required to delimit *Anastrepha* spp. infestation in the core and designated buffer areas

Delimitation Area	Total Square Miles	# Traps per Square Mile	Total Traps
Core	1	80	80
1st buffer area	8	40	320
2nd buffer area	16	20	320
3rd buffer area	24	10	240
4th buffer area	32	5	160
Total	81	NA	1120

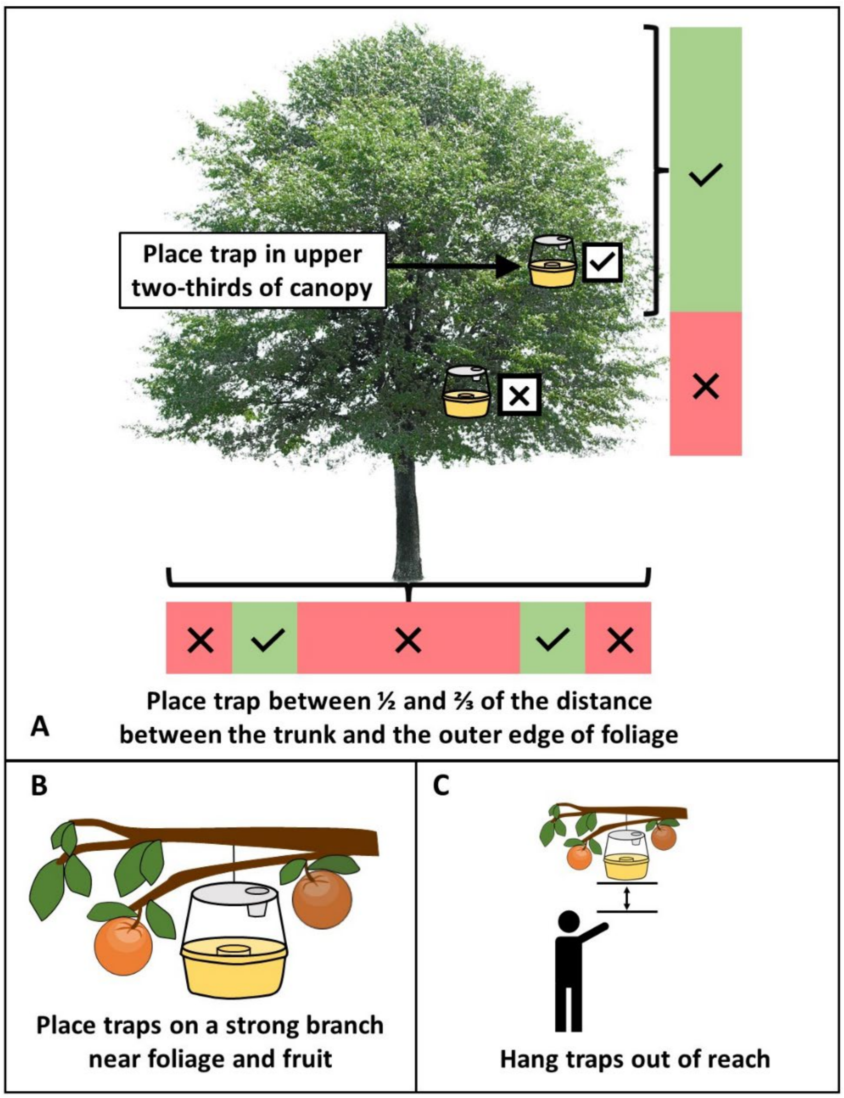

Figure 4-2 Best practices for placing traps in the core and buffer areas to delimit *Anastrepha* spp. infestation

Fruit Sampling

Fruit sampling is required to determine if the detected species has started reproducing in the area. Randomly collect 100 or more preferred host fruits (if available, see Hosts) from the initial detection site and visually inspect for possible signs of oviposition. If there are no visible signs, cut open the fruits and inspect for larval presence. Take care not to miss any early larval instars that might be feeding immediately under the skin of fruits. If two or more flies are trapped in the vicinity, fruit inspection may be expanded to cover all preferred host trees within a 656 ft (200 m) radius of detection. Fruit should not be moved from the site of detection during inspection and sampled fruits must be destroyed (see Fruit Removal) (USDA-APHIS, 2015b; USDA-APHIS-PPQ, 2021).

Delimitation Survey

To delimit *Anastrepha* spp. infestation using a core and buffer grid design:

1. Identify and survey the core area.
    a. Using a map or mapping software, establish a one-square mile core area around the initial detection site (Fig. 4-3).
    b. Place 80 traps in the core area. Increase existing trap density to 80 traps/square mile, for example, if there are already five traps in the area, add 75 more to achieve a total of 80 traps in the area.

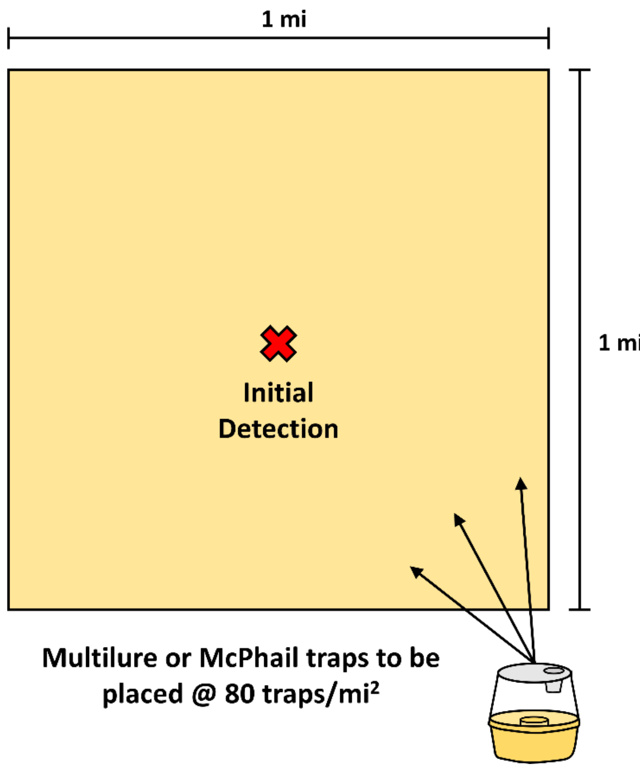

Figure 4-3 Trapping in the core area requires 80 traps.

c. Distribute the traps evenly throughout the core area based on the host tree distribution patterns (see Trap Placement).
d. If multiple flies are detected within the existing core area, do not expand the core area.
e. If an additional detection is made outside the initial core area, establish a new core area around the detection with 80 traps per square mile.
f. Service traps daily for the first week following detection. If there are no additional detections, service traps weekly and keep in place according to the guidelines in Timing of Surveys.

2. Identify and survey the buffer area
   a. Using a map or mapping software, establish four concentric buffer areas moving outward from the core.
   b. Place traps with a density of 40-20-10-5 traps per square mile in successive buffer areas, moving outward from the core (Table 4-2).
   c. Distribute the traps evenly throughout the buffer area based on the host tree distribution patterns (see Trap Placement).
   d. If no new detections are made in the core or buffer areas, continue delimitation survey for three generations of the detected *Anastrepha* spp.

Survey Grid Modification

If an additional adult fruit fly is detected during the trapping period in the buffer area:

a. Increase the trap density to 80 traps per square mile around the new detection site.
b. Expand and modify the existing trap array to align with the new core (Fig. 4-4) and adjust trapping densities in the new buffer area.
c. Service the traps in the new core twice weekly and service traps in the buffer areas weekly. Keep traps in place according to the guidelines in Timing of Surveys.

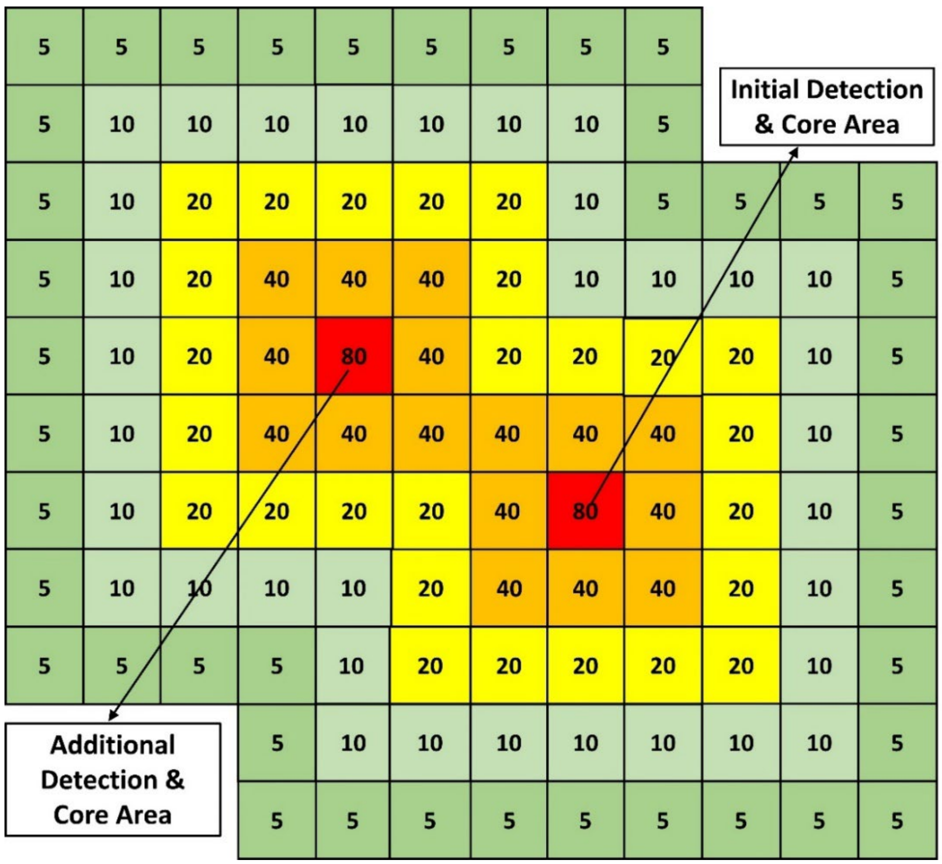

Figure 4-4 Expansion of the existing survey grid and trapping layout if an additional detection occurs in the buffer area

Chapter 5

Eradication and Control Options

Overview

This information can be used by PPQ decision-makers after an eradication or quarantine-triggering detection to determine the best course of action to eradicate the incursion of *Anastrepha* spp. most expeditiously. The efficacy and feasibility of each control option will depend on the pest situation at the time of detection. Factors, such as where the pest is detected (i.e., natural or urban environments, agricultural crops, greenhouses), how widespread the pest is, the climatic region, the time of year, the phenology of the hosts, and current practices already in place, contribute to determining whether a particular control option is appropriate.

Eradication and Control Options

A combination of the following mitigation options can be used in a systems approach to eradicate *Anastrepha* spp. These protocols are based on the USDA-APHIS preferred alternative for the eradication of these fruit flies (USDA-APHIS-PPQ, 2021). Mitigation options include:

- Host fruit removal to target immature stages.
- Chemical control using insecticide-based foliar bait spray treatments to target adults and soil drenching with insecticide to prevent larvae or pupae maturing to adults.
- Regulatory quarantine procedures to prevent the spread of *Anastrepha* spp.

Public Notification

Before the eradication process begins, inform the public and potentially affected industries about the eradication and quarantine process via press releases, meetings, or any other appropriate forms of communication. Notify residents, owners or operators of groves, vendors, nurseries, and other related industries whose property will be impacted at least 48 hours in advance of treatment or fruit removal (USDA-APHIS-PPQ, 2021; USDA-APHIS, 2015b).

Fruit Removal

Strip all host fruits within a 656 ft (200 m) radius of the site where the eradication-triggering detection(s) occurred. Destroy stripped host fruits either by bagging in heavy-duty plastic bags, burying them at an approved landfill at least one foot deep, or by incineration (USDA-APHIS, 2001, 2018).

Chemical Control Options

Insecticide classes listed in Table 5-1 are reported to be effective against various *Anastrepha* spp. Insecticides in the table are registered in the United States, although some are not registered for use against fruit flies.

Table 5-1 Insecticides with efficacy for use against *Anastrepha* spp.[1]

IRAC Insecticide Class (Mode of Action)[2]	Active Ingredient	Fruit Fly Species	Insecticide Application	Efficacy	References
Carbamates (1A)	methomyl**	*A. suspensa*	applied as a bait station	98%	Heath et al., 2009
Organophosphates (1B)	dimethoate*	*A. suspensa*	applied as a bait station	99%	Heath et al., 2009
Organophosphates (1B)	malathion*	*A. fraterculus*; *A. grandis*	applied as a bait station; foliar spray	>90%	Nunes et al., 2020; Raga et al., 2018
Organophosphates (1B)	phosmet*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Pyrethroids (3A)	deltamethrin*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Pyrethroids (3A)	alpha-cypermethrin**	*A. fraterculus*	applied as a bait station	>97%	Nunes et al., 2020
Pyrethroids (3A)	zeta-cypermethrin*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Neonicotinoids (4A)	acetamiprid*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Neonicotinoids (4A)	imidacloprid*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Neonicotinoids (4A)	thiamethoxam*	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Butenolides (4D)	flupyradifurone **	*A. fraterculus*; *A. grandis*	foliar spray	100%	Raga et al., 2018
Spinosyns (5)	spinetoram*	*A. obliqua*	applied as a bait station	96%	Raga et al., 2021
Spinosyns (5)	spinosad*	*A. fraterculus*; *A. grandis*; *A. suspensa*	applied as a bait station	82-100%	Heath et al., 2009; Nunes et al., 2020; Raga et al., 2019

IRAC Insecticide Class (Mode of Action)[2]	Active Ingredient	Fruit Fly Species	Insecticide Application	Efficacy	References
UNE	neem oil*	*A. fraterculus*	applied to infested fruit	45-93% depending on life stage	Raga et al., 2020

[1] Registration status and pest labeling confirmed by CDMS, 2022 and EPA, 2023. Note that U.S. states, tribes, and territories can have additional registration requirements and may have restrictions on pesticides used or sold within their jurisdictions. Registration and site restrictions should be confirmed prior to setting up any control programs.

[2] MOA: Insecticide acts on nerve & muscle (1A, 1B, 3A, 4A, 4D, 5). For full definitions for each mode of action see https://irac-online.org/modes-of-action.

* Registered for use against fruit flies in the United States.

** Registered in the United States, but no commercial products available for fruit flies.

Foliar Bait Spray Treatments

Apply foliar bait spray insecticides either as a targeted ground treatment within a 0.3 mile radius of each detection site or as an aerial treatment to orchards growing *Anastrepha* hosts (see Hosts, Chemical Control Options). Protein hydrolysate (derived from plants or yeast) is generally recommended as the bait. (USDA-APHIS-PPQ, 2021).

Soil Drenching

Soil drenching kills developing pupae in the soil. Apply approved insecticides (see Chemical Control Options) within existing driplines under host trees within a 1312 ft radius of the detection (USDA-APHIS-PPQ, 2021).

Regulatory Quarantine Procedures

Regulatory quarantine procedures and controlling movement of host materials from the quarantine areas will limit the spread of *Anastrepha* spp. from infested areas. If an infestation is confirmed and Emergency Response Triggers for quarantine are met, state program personnel will issue ‘hold orders’ on all infested properties and an emergency quarantine will be established (USDA-APHIS, 2015b; USDA-APHIS-PPQ, 2021).

Any area that falls within a 4.5 mile radius of a confirmed infestation will be treated as a quarantine area (USDA-APHIS, 2015b). Quarantines will remain in effect for three *Anastrepha* life cycles from the date of the last detection, until eradication is declared (USDA-APHIS-PPQ, 2021; USDA-APHIS, 2015b).

Regulatory Phytosanitary Treatment

Post-harvest phytosanitary measures may be required to kill fruit flies from the quarantine areas. These measures include cold and hot water treatments, irradiation with gamma rays and fumigation with methyl bromide (IPPC, 2019). Refer to the USDA APHIS Treatment Manual for detailed instructions for post-harvest treatment of fruit flies (USDA-APHIS-PPQ, 2021; USDA-APHIS, 2018).

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Appendix

A

Environmental Compliance

Introduction

Use Appendix A as a guide to environmental regulations pertinent to *Anastrepha* spp.

Overview

Program managers of Federal emergency response or domestic pest control programs must ensure that their programs comply with all Federal Acts and Executive Orders pertaining to the environment, as applicable. Two primary Federal Acts, the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), often require the development of significant documentation before program actions may commence. APHIS, Policy and Program Development, Environmental and Risk Analysis Services (ERAS) is available to provide guidance to program managers and prepare drafts of applicable environmental documentation. PPQ's Compliance and Environmental Coordination program assists ERAS in development of documents and implements environmental monitoring. Program leadership is strongly advised to consult with ERAS and/or the Compliance and Environmental Coordination program early in the development of a program to conduct a preliminary review of applicable environmental statutes and ensure timely compliance.

Environmental monitoring of APHIS pest control activities may be required as part of compliance with environmental statutes, as requested by program managers, or as suggested to address concerns with controversial activities. Monitoring may be conducted with regards to worker exposure, pesticide quality assurance and control, off-site chemical deposition, or program efficacy. Different tools and techniques are used depending on the monitoring goals and control techniques used in the program. Staff from ECT will work with the program manager to develop an environmental monitoring plan, conduct training to implement the plan, provide day-to-day guidance on monitoring, and provide an interpretive report of monitoring activities.

The following is a list of pertinent laws and Executive Orders:

National Environmental Policy Act (NEPA) – NEPA requires all Federal agencies to examine whether their actions may significantly affect the quality of the human environment. The purpose of NEPA is to inform the decision-maker prior to taking action and to inform the public of the decision. Actions that are excluded from this examination, actions that normally require an Environmental Assessment, and actions that normally require Environmental Impact Statements are codified in APHIS' NEPA Implementing Procedures located in 7 CFR 372.5.

The three types of NEPA documentation are:

1. **Categorical Exclusion**

   Categorical exclusions are classes of actions that do not have a significant effect on the quality of the human environment and for which neither an environmental assessment (EA) nor an environmental impact statement (EIS) is required. Generally, the means through which adverse environmental impacts may be avoided or minimized have actually been built into the actions themselves (see 7 CFR 372.5(c)).

2. **Environmental Assessment (EA)**

   An EA is a public document that succinctly presents information and analysis for the decision-maker of the proposed action. An EA can lead to the preparation of an environmental impact statement (EIS), a finding of no significant impact (FONSI), or the abandonment of a proposed action.

3. **Environmental Impact Statement (EIS)**

   In the event that a major Federal action may significantly affect the quality of the human environment (adverse or beneficial), or, the proposed action may result in public controversy, an EIS is prepared.

Endangered Species Act (ESA) – This statute requires that programs consider their potential effects on federally protected species. The ESA requires programs to identify protected species and their habitat in or near program areas and documentation of how adverse effects to these species will be avoided. The documentation may require review and approval by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service before program activities can begin. Knowingly violating this law can lead to criminal charges against individual staff members and program managers.

Migratory Bird Treaty Act – This statute requires that programs avoid harm to over 800 endemic bird species, eggs, and their nests. In some cases, permits may be available to capture birds, which require coordination with the U.S. Fish and Wildlife Service.

Clean Water Act – This statute requires various permits for work in wetlands and for potential discharges of program chemicals into water. This may require coordination with the Environmental Protection Agency, individual states, and the U.S. Army Corps of Engineers. Such permits would be required even if the pesticide label allows for direct application to water.

Tribal Consultation – This Executive Order requires formal government to government communication if a program might have substantial direct effects on any federally-recognized Indian Nation. This process is often incorrectly included as part of the NEPA process, but it must be completed prior to general public involvement under NEPA. Staff should be cognizant of the conflict that could arise when proposed federal actions intersect with tribal sovereignty. Tribal consultation is designed to identify and avoid such potential conflict.

National Historic Preservation Act – This statute requires programs to consider potential impacts on historic properties (such as buildings and archaeological sites) and requires coordination with local State Historic Preservation Offices. Documentation under this Act involves inventorying the project area for historic properties and determining what effects, if any, the project may have on them. This process may require public involvement and comment prior to the start of program activities.

Coastal Zone Management Act – This statute requires coordination with states where programs may impact Coastal Zone Management Plans. Federal activities that may affect coastal resources are evaluated through a process called "federal consistency". This process allows the public, local governments, Tribes, and state agencies an opportunity to review the federal action. The federal consistency process is administered individually by states with Coastal Zone Management Plans.

Environmental Justice – This Executive Order requires consideration of program impacts on minority and economically disadvantaged populations. Compliance is usually achieved within the NEPA documentation for a project. Programs are required to consider if the actions might disproportionally impact minority or economically disadvantaged populations, and if so, how such impact will be avoided.

Protection of Children –This Executive Order requires federal agencies to identify, assess, and address environmental health risks and safety risks that may disproportionately affect children. If such a risk is identified, then measures must be described and implemented to minimize such risks.

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