INTERNATIONAL STANDARDS FOR
PHYTOSANITARY MEASURES

ISPM 26

Establishment of pest free areas for fruit flies (Tephritidae)

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This is not an official part of the standard

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2004-11 SC approved Specification 27 *Pest free areas for fruit flies.*

2005-04 SC revised draft and approved for member consultation.

2005-06 Member consultation.

2005-09 TPFF revised draft text.

2005-11 SC approved draft to be submitted for adoption.

2006-04 CPM-1 revised and adopted standard.

ISPM 26. 2006. *Establishment of pest free areas for fruit flies* (*Tephritidae*). Rome, IPPC, FAO.

2006-04 CPM-1 added topic *Trapping procedures for fruit flies* (2006-037).

2006-05 SC approved Specification 35 *Trapping procedures for fruit flies of the family Tephritidae.*

2007-12 TPFF developed draft text cooperated with IAEA.

2008-05 SC approved draft for member consultation.

2008-06 Member consultation.

2009-05 SC revised draft and proposed as Appendix to ISPM 26.

2009-05 SC-7 revised draft.

2009-11 SC revised draft.

2010-03 CPM-5 reviewed draft and returned to SC with guidance for modifications.

2010-04 SC reviewed draft and returned to TPFF.

2010-10 TPFF revised draft.

2010-11 SC approved draft to be submitted for adoption.

2011-03 CPM-6 revised and adopted Appendix 1.

2009-11 SC introduced topic *Establishment and maintenance of regulated areas upon outbreak detection in fruit fly free areas* (2009-007).

2010-03 CPM-5 added topic (2009-007).

2010-11 SC approved draft specification for member consultation.

2011-02 Member consultation

2011-05 SC revised and approved Specification 53.

2011-08 TPFF developed draft text.

2012-04 SC revised and approved draft for member consultation.

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2005-11 SC recommended topic: *Suppression and eradication procedures for fruit flies* (2005-010) to be added to the work programme.

2006-04 CPM-1 (2006) added topic (2005-010).

2006-11 SC approved Specification 39.

2009-09 TPFF drafted text.

2011-01 TPFF recommended draft ISPM *Phytosanitary Procedures for Fruit Fly (Tephritidae) Management* (2005-010) to SC as an annex to ISPM 26.

2011-05 SC noted TPFF recommendation.

2012-04 SC reviewed draft ISPM and returned it to steward for redrafting.

2012-12 Steward revised draft in consultation with TPFF.

2013-05 SC revised in meeting and approved for MC.

2013-07 MC.

2014-02 Steward revised draft ISPM.

2014-05 SC-7 revised and approved for SCCP.

2014-07 SCCP.

2014-11 Steward revised draft after SCCP.

2014-11 SC revised and approved for CPM adoption.

2015-03 CPM adopted Annex 3.

2015-03 CPM-10 noted ink amendments in relation to “phytosanitary status”.

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2018-04 CPM-13 noted ink amendments in relation to reorganization, harmonization and minor technical updates of the fruit flies ISPMs and revoked previous version of ISPM 26.

2018-09 IPPC Secretariat incorporated ink amendments and applied minor edits.

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CONTENTS

Adoption

This standard was adopted by the First Session of the Commission on Phytosanitary Measures in April 2006. Revision of Appendix 1 was adopted by the Sixth Session of the Commission on Phytosanitary Measures in March 2011. Annex 2 was adopted by the Ninth Session of the Commission on Phytosanitary Measures in April 2014. Annex 3 was adopted by the Tenth Session of the Commission on Phytosanitary Measures in March 2015.

INTRODUCTION

Scope

This standard provides guidance for the establishment of pest free areas for fruit flies (Tephritidae) of economic importance, and for the maintenance of their pest free status.

References

The present standard refers to ISPMs. ISPMs are available on the International Phytosanitary Portal (IPP) at https://www.ippc.int/core-activities/standards-setting/ispms.

IPPC. 1997. *International Plant Protection Convention*. Rome, IPPC, FAO.

Definitions

Definitions of phytosanitary terms used in this standard can be found in ISPM 5 (*Glossary of phytosanitary terms*).

Outline of Requirements

The general requirements for establishing a fruit fly pest free area (FF-PFA) include:

- the preparation of a public awareness programme
- the management elements of the system (documentation and review systems, recordkeeping)
- supervision activities.

The major elements of an FF-PFA are:

- the characterization of the FF-PFA
- the establishment and maintenance of the FF-PFA.

These elements include the surveillance activities of fruit fly trapping (described in Appendix 1) and fruit sampling (described in Appendix 2), and official control on the movement of regulated articles.

Additional elements include: corrective action planning, and suspension, reinstatement (if possible) and revocation of pest free status of the FF-PFA. Corrective action plans are described in Annex 1, control measures for an outbreak within a fruit fly pest free area in Annex 2 and phytosanitary procedures for fruit fly management in Annex 3.

BACKGROUND

Fruit flies are a very important group of pests for many countries because of their potential to cause damage in fruits and to their potential to restrict access to international markets for plant products that can host fruit flies. The high probability of introduction of fruit flies associated with a wide range of hosts results in restrictions imposed by many importing countries on accepting fruits from areas in which these pests are established. For these reasons, there is a need for an ISPM that provides specific guidance for the establishment and maintenance of pest free areas for fruit flies.

A pest free area is "an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained" (ISPM 5). Areas initially free from fruit flies may remain naturally free from fruit flies as a result of the presence of barriers or climatic conditions, and/or may be maintained free through movement restrictions and related measures (though fruit flies have the potential to establish there) or may be made free by an eradication programme (ISPM 9 (*Guidelines for pest eradication programmes*)). ISPM 4 (*Requirements for the establishment of pest free areas*) describes different types of pest free areas and provides general guidance on the establishment of pest free areas. However, a need for additional guidance on the establishment and maintenance of pest free areas specifically for fruit flies was recognized. This standard describes additional requirements for the establishment and maintenance of FF-PFAs. The target pests for which this standard was developed include insects of the order Diptera, family Tephritidae, genera *Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis* and *Toxotrypana*.

The establishment and maintenance of an FF-PFA implies that no other phytosanitary measures specific for the target species are required for host commodities within the pest free area.

REQUIREMENTS

1. General Requirements

The concepts and provisions of ISPM 4 apply to the establishment and maintenance of pest free areas for all pests, including fruit flies, and therefore ISPM 4 should be referred to in conjunction with this standard.

Phytosanitary measures and specific procedures as further described in this standard may be required for the establishment and maintenance of an FF-PFA. The decision to establish an FF-PFA may be made based on the technical factors provided in this standard. They include components such as pest biology, size of the area, pest population levels and dispersal pathway, ecological conditions, geographical isolation and availability of methods for pest eradication.

FF-PFAs may be established in accordance with this ISPM under a variety of situations. Some of them require the application of the full range of elements provided by this standard; others require only the application of some of these elements.

In areas where the fruit flies concerned are not capable of establishment because of climatic, geographical or other reasons, there should be no records of presence and it may be reasonable to conclude that the pest is absent (ISPM 8 (*Determination of pest status in an area*)). If, however, the fruit flies are detected and can cause economic damage during a season (Article VII.3 of the IPPC), corrective actions should be applied in order to allow the maintenance of an FF-PFA.

In areas where the fruit flies are capable of establishment and known to be absent, general surveillance in accordance with ISPM 8 is normally sufficient for the purpose of delimiting and establishing a pest free area. Where appropriate, import requirements and/or domestic movement restrictions against the introduction of the relevant fruit fly species into the area may be required to maintain the area free from the pest.

1.1 Public awareness

A public awareness programme is most important in areas where the risk of introduction is higher. An important factor in the establishment and maintenance of FF-PFAs is the support and participation of the public (especially the local community) close to the FF-PFA and individuals who travel to or through the area, including parties with direct and indirect interests. The public and stakeholders should be informed through different media (written, radio, television) of the importance of establishing and maintaining the pest free status of the area, and of avoiding the introduction or reintroduction of potentially infested host material. This may contribute to and improve compliance with the phytosanitary measures for the FF-PFA. The public awareness and phytosanitary education programme should be ongoing and may include information on:

- permanent or random checkpoints
- posting signs at entry points and transit corridors
- disposal bins for host material
- leaflets or brochures with information on the pest and the pest free area
- publications (e.g. print, electronic)
- systems to regulate fruit movement
- non-commercial hosts
- security of the traps
- penalties for non-compliance, where applicable.

1.2 Documentation and record keeping

The phytosanitary measures used for the establishment and maintenance of an FF-PFA should be adequately documented as part of phytosanitary procedures. They should be reviewed and updated regularly, and include corrective actions, if required (see also ISPM 4).

The records of surveys, detections, occurrences or outbreaks and results of other operational procedures should be retained for at least 24 months. Such records should be made available to the national plant protection organization (NPPO) of the importing country on request.

1.3 Supervision activities

The FF-PFA programme, including regulatory control, surveillance procedures (e.g. trapping, fruit sampling – see details in Appendix 1 and Appendix 2, respectively) and corrective action planning should comply with officially approved procedures.

Such procedures should include delegation of responsibility assigned to key personnel, for example:

- a person with defined authority and responsibility to ensure that the procedures are implemented and maintained appropriately
- entomologist(s) with responsibility for the authoritative identification of fruit flies to species level.

The effectiveness of the programme should be monitored periodically by the NPPO of the exporting country, through review of documentation and procedures.

2. Specific Requirements

2.1 Characterization of the FF-PFA

The determining characteristics of the FF-PFA include:

- the target fruit fly species and its distribution within or adjacent to the area
- commercial and non-commercial host species

- delimitation of the area (detailed maps or global positioning system (GPS) coordinates showing the boundaries, natural barriers, entry points and host area locations, and, where necessary, buffer zones)
- climate, for example rainfall, relative humidity, temperature, prevailing wind speed and direction.

Further guidance on establishing and describing a pest free area is provided in ISPM 4.

2.2 Establishment of the FF-PFA

The following should be developed and implemented when establishing an FF-PFA:

- surveillance activities for the establishment of the FF-PFA
- delimitation of the FF-PFA
- phytosanitary measures related to movement of host material or regulated articles
- pest suppression and eradication techniques, as appropriate.

The establishment of buffer zones may also be necessary (as described in section 2.2.1) and it may be useful to collect additional technical information during the establishment of the FF-PFA.

2.2.1 Buffer zone

In areas where geographic isolation is not considered adequate to prevent introduction to or reinfestation of a pest free area or where there are no other means of preventing fruit fly movement to the pest free area, a buffer zone should be established. Factors that should be considered in the establishment and effectiveness of a buffer zone include:

- pest suppression techniques, which may be used to reduce the fruit fly population, including:
  - use of selective insecticide bait
  - spraying
  - sterile insect technique
  - male annihilation technique
  - biological control
  - mechanical control, etc.
- host availability, cropping systems, natural vegetation
- climatic conditions
- the geography of the area
- the capacity for natural spread through identified pathways
- the ability to implement a system to monitor the effectiveness of buffer zone establishment (e.g. trapping network).

2.2.2 Surveillance activities before establishment

A regular survey programme should be established and implemented. Trapping is the preferred option to determine fruit fly absence or presence in an area for lure or bait-responsive species. However, fruit sampling activities may sometimes be required to complement the trapping programme in cases where trapping is less effective, for example when species are less responsive to specific lures.

Before the establishment of an FF-PFA, surveillance should be undertaken for a period determined by the climatic characteristics of the area, and as technically appropriate, for at least 12 consecutive months in the FF-PFA in all relevant areas of commercial and non-commercial host plants to demonstrate that the pest is not present in the area. There should be no populations detected during the surveillance activities before establishment. A single adult detection, depending on its status (in accordance with ISPM 8), may not disqualify an area from subsequent designation as an FF-PFA. For qualifying the area as a pest free area, there should be no detection of an immature specimen, two or

more fertile adults, or an inseminated female of the target species during the survey period. There are different trapping and fruit sampling regimes for different fruit fly species. Surveys should be conducted following the guidance in Appendix 1 and Appendix 2. These appendices may be revised as trap, lure and fruit sampling efficiencies improve.

2.2.2.1 Trapping procedures

This section contains general information on trapping procedures for target fruit fly species. Trapping conditions may vary depending on, for example, the target fruit fly and environmental conditions. More information is provided in Appendix 1. When planning for trapping, the following should be considered.

Trap type and lures

Several types of traps and lures have been developed over decades to survey fruit fly populations. Fly catches differ depending on the types of lure used. The type of trap chosen for a survey depends on the target fruit fly species and the nature of the attractant. The most widely used traps include Jackson, McPhail, Steiner, open bottom dry trap, yellow panel traps, which may use specific attractants (parapheromone or pheromone lures that are male specific), or food or host odours (liquid protein or dry synthetic protein). Liquid protein is used to catch a wide range of different fruit fly species and to capture both females and males, with a slightly higher percentage of females captured. However, identification of the fruit flies can be difficult because of decomposition within the liquid bait. In traps such as McPhail, ethylene glycol may be added to delay decomposition. Dry synthetic protein baits are female biased, capture fewer non-target organisms and, when used in dry traps, may prevent premature decomposition of captured specimens.

Trap density

Trap density (number of traps per unit area) is a critical factor for effective fruit fly surveys and it should be designed based on target fruit fly species, trap efficiency, cultivation practices, and other biotic and abiotic factors. Density may change depending on the programme phase, with different densities required during the establishment of an FF-PFA and the maintenance phase. Trap density also depends on the risk associated with potential pathways for entry into the designated pest free area.

Trap deployment

In an FF-PFA programme, an extensive trapping network should be deployed over the entire area (i.e. determination of the specific location of the traps). The trapping network layout will depend on the characteristics of the area, host distribution and the biology of the fruit fly of concern. One of the most important features of trap placement is the selection of a proper location and trap site within the host plant. The application of GPS and geographic information systems (GIS) are useful tools for the management of a trapping network.

Trap location should take into consideration the presence of hosts (primary, secondary and occasional) of the target species. Because the pest is associated with maturing fruit, the location, including rotation, of traps should follow the sequence of fruit maturity in host plants. Consideration should be given to commercial management practices in the area where host trees are selected. For example, the regular application of insecticides (and/or other chemicals) to selected host trees may have a false-negative effect on the trapping programme.

Trap servicing

The frequency of trap servicing (maintaining and refreshing the traps) during the period of trapping should depend on the:

- longevity of baits (attractant persistency)
- retention capacity
- rate of catch
- season of fruit fly activity

- placement of the traps
- biology of the species
- environmental conditions.

Trap inspection

The frequency of inspection (checking the traps for fruit flies) during the period of trapping should depend on:

- expected fruit fly activity (biology of the species)
- the response of the target fruit fly in relation to host status (ISPM 37 (*Determination of host status of fruit to fruit flies (Tephritidae)*)) at different times of the year
- the relative number of target and non-target fruit flies expected to be caught in a trap
- type of trap used
- the physical condition of the flies in the trap (and whether they can be identified).

In certain traps, specimens may degrade quickly making identification difficult or impossible unless the traps are checked frequently.

Identification capability

NPPOs should have in place, or have ready access to, adequate infrastructure and trained personnel to identify fruit fly specimens of the target species in an expeditious manner, preferably within 48 hours. Continuous access to expertise may be necessary during the establishment phase or when implementing corrective actions.

2.2.2.2 Fruit sampling procedures

Fruit sampling may be used as a surveillance method in combination with trapping where trapping is less effective. It should be noted that fruit sampling is particularly effective in small-scale delimiting surveys in an outbreak area. However, it is labour-intensive, time consuming and expensive because of the destruction of fruit. It is important that fruit samples should be held in suitable conditions to maintain the viability of all immature stages of fruit flies in infested fruit for identification purposes. Further information is provided in Appendix 2.

Host preference

Fruit sampling should take into consideration the presence of primary, secondary and occasional hosts of the target species. Fruit sampling should also take into account the maturity of fruit, apparent signs of infestation in fruit, and commercial practices (e.g. application of insecticides) in the area.

High-risk areas

Fruit sampling should be targeted to areas likely to have presence of infested fruits such as:

- urban areas
- abandoned orchards
- rejected fruit at packing facilities
- fruit markets
- sites with a high concentration of primary hosts
- entrance points in to the FF-PFA, where appropriate.

The sequence of hosts that are likely to be infested by the target fruit fly species in the area should be used as fruit sampling areas.

Sample size and selection

Factors to be considered include:

- the required level of confidence

- the availability of primary host material in the field
- fruits with symptoms on trees, fallen or rejected fruit (e.g. at packing facilities), where appropriate.

Procedures for processing sampled fruit for inspection

Fruit samples collected in the field should be brought to a facility for holding, fruit dissection, and pest recovery and identification. Fruit should be labelled, transported and held in a secure manner to avoid mixing fruits from different samples.

Identification capability

NPPOs should have in place, or have ready access to, adequate infrastructure and trained personnel to identify fruit fly immature stages and emerged adults of the target species in an expeditious manner.

2.2.3 Controls on the movement of regulated articles

Controls on the movement of regulated articles should be implemented to prevent the entry of target pests into the FF-PFA. These controls depend on the assessed risks (after identification of likely pathways and regulated articles) and may include:

- listing of the target fruit fly species on a quarantine pest list
- regulation of the pathways and articles that require control to maintain the FF-PFA
- domestic restrictions to control the movement of regulated articles into the FF-PFA
- inspection of regulated articles, examination of relevant documentation as appropriate and, where necessary for cases of non-compliance, the application of appropriate phytosanitary measures (e.g. treatment, refusal or destruction).

2.2.4 Additional technical information for the establishment of an FF-PFA

Additional information that may be useful during the establishment phase of FF-PFAs includes:

- historical records of detection, biology and population dynamics of the target pest(s), and survey activities for the designated target pest(s) in the FF-PFA
- the results of phytosanitary measures taken as part of actions following detections of fruit flies in the FF-PFA
- records of the commercial production of host crops in the area, an estimate of non-commercial production and the presence of wild host material
- lists of the other fruit fly species of economic importance that may be present in the FF-PFA.

2.2.5 Domestic declaration of pest freedom

The NPPO should verify the fruit fly free status of the area (in accordance with ISPM 8) specifically by confirming compliance with the procedures established in accordance with this standard (surveillance and controls). The NPPO should declare and notify the establishment of the FF-PFA, as appropriate.

In order to be able to verify the fruit fly free status in the area and for the purpose of internal management, the continuing FF-PFA status should be checked after the FF-PFA has been established and any phytosanitary measures for the maintenance of the FF-PFA have been put in place.

2.3 Maintenance of the FF-PFA

In order to maintain the FF-PFA status, the NPPO should monitor the surveillance and control activities, continuously verifying the pest free status.

2.3.1 Surveillance for the maintenance of the FF-PFA

After verifying and declaring the FF-PFA, the surveillance programme should be continued at a level assessed as being necessary for the maintenance of the FF-PFA. Regular technical reports on the

survey activities should be generated (e.g. monthly). Requirements for this are essentially the same as for the establishment of the FF-PFA (see section 2.2) but with differences in trap density and trap deployment dependent upon the assessed level of risk of introduction of the target species.

2.3.2 Controls on the movement of regulated articles

These are the same as for the establishment of the FF-PFA (provided in section 2.2.3).

2.3.3 Corrective actions (including response to an outbreak)

The NPPO should have plans prepared for corrective actions that may be implemented if the target pest(s) is detected in the FF-PFA or in host material from that area (detailed guidance is provided in Annex 1, Annex 2 and Annex 3), or if faulty procedures are found. These plans should include components or systems to cover:

- outbreak declaration, according to criteria in ISPM 8, and notification
- delimiting surveillance (trapping and fruit sampling) to determine the infested area under corrective actions
- the implementation of control measures
- further surveillance
- criteria for the reinstatement of freedom of the area affected by the outbreak
- responses to interceptions.

A corrective action plan should be initiated as soon as possible and in any case within 72 hours of the detection (of an adult or immature stage of the target pest).

2.4 Suspension, reinstatement or revocation of an FF-PFA status

2.4.1 Suspension

The status of the FF-PFA or the affected part within the FF-PFA should be suspended when an outbreak of the target fruit fly occurs or based on one of the following triggers: detection of an immature specimen of the target fruit fly; detection of two or more fertile adults as demonstrated by scientific evidence; or detection of an inseminated female within a defined period and distance. Suspension may also be applied if procedures are found to be faulty (e.g. inadequate trapping, host movement controls or treatments).

If the criteria for an outbreak are met, this should result in the implementation of the corrective action plan as specified in this standard and immediate notification to interested importing countries' NPPOs (see ISPM 17 (*Pest reporting*)). The whole or part of the FF-PFA may be suspended or revoked. In most cases a suspension radius will delimit the affected part of the FF-PFA. The radius will depend on the biology and ecology of the target fruit fly. The same radius will generally apply for all FF-PFAs for a given target species unless scientific evidence supports any proposed deviation. Where a suspension is put in place, the criteria for lifting the suspension should be made clear. Interested importing countries' NPPOs should be informed of any change in FF-PFA status.

2.4.2 Reinstatement

Reinstatement should be based on requirements for establishment with the following conditions:

- no further detection of the target pest species for a period determined by the biology of the species and the prevailing environmental conditions[1], as confirmed by surveillance, or
- in the case of a fault in the procedures, only when the fault has been corrected.

[1] The period starts from the last detection. For some species, no further detection should occur for at least three life cycles; however, the required period should be based on scientific information, including that provided by the surveillance systems in place.

2.4.3 Revocation

If the control measures are not effective and the pest becomes established in the whole area (the area recognized as pest free), the status of the FF-PFA should be revoked. In order to achieve again the FF-PFA, the procedures of establishment and maintenance outlined in this standard should be followed.

This annex is a prescriptive part of the standard.

ANNEX 1: Corrective action plans

The detection of a single fruit fly (adult or immature stage) of the target species in the FF-PFA should trigger the enforcement of a corrective action plan.

In case of an outbreak, the objective of the corrective action plan is to ensure eradication of the pest to enable reinstatement of the affected area into the FF-PFA.

The corrective action plan should be prepared taking into account the biology of the target fruit fly species, the geography of the FF-PFA area, climatic conditions and host distribution within the area.

The elements required for implementation of a corrective action plan include:

- a legal framework under which the corrective action plan can be applied
- criteria for the declaration of an outbreak
- time scales for the initial response
- technical criteria for delimiting trapping, fruit sampling, application of the eradication actions and establishment of regulatory measures
- the availability of sufficient operational resources
- identification capability
- effective communication within the NPPO and with the NPPO(s) of the importing country(ies), including provision of contact details of all parties involved.

1. Actions to apply the corrective action plan

(1) *Determination of the pest status of the detection (actionable or non-actionable)*

(1.1) If the detection is a transient non-actionable occurrence (ISPM 8), no further action is required.

(1.2) If the detection of a target pest may be actionable, a delimiting survey, which includes additional traps, and usually fruit sampling as well as an increased trap inspection rate, should be implemented immediately after the detection to assess whether the detection represents an outbreak, which will determine necessary responsive actions. If a population is present, this action is also used to determine the size of the affected area.

(2) *Suspension of FF-PFA status*

If after detection it is determined that an outbreak has occurred or any of the triggers specified in section 2.4.1 of this standard is reached, the FF-PFA status in the affected area should be suspended. The affected area may be limited to parts of the FF-PFA or may be the whole FF-PFA.

(3) *Implementation of control measures in the affected area*

As per ISPM 9, specific corrective or eradication actions should be implemented immediately in the affected area and adequately communicated to the community. Eradication actions may include:

- selective insecticide bait treatments
- sterile fly release
- total harvest of fruit in the trees
- male annihilation technique
- destruction of infested fruit
- soil treatment (chemical or physical)
- insecticide application.

Phytosanitary measures should be immediately enforced for control of movement of regulated articles that can host fruit flies. These measures may include the cancellation of shipments of fruit commodities from the affected area and, as appropriate, fruit disinfestation and the operation of road

blocks to prevent the movement of infested fruit from the affected area to the rest of the pest free area. Other measures could be adopted if agreed by the importing country, for example, treatment, increased surveys or supplementary trapping.

(4) *Criteria for reinstatement of an FF-PFA after an outbreak and actions to be taken*

The criteria for determining that eradication has been successful are specified in section 2.4.2 of this standard and should be included in the corrective action plan for the target fruit fly. The time period will depend on the biology of the species and the prevailing environmental conditions. Once the criteria have been fulfilled the following actions should be taken:

- notification of NPPOs of importing countries
- reinstatement of normal surveillance levels
- reinstatement of the FF-PFA.

(5) *Notification of relevant agencies*

Relevant NPPOs and other agencies should be kept informed of any change in FF-PFA status, as appropriate, and IPPC pest reporting obligations observed (ISPM 17).

This annex is a prescriptive part of the standard.

ANNEX 2: Control measures for an outbreak within a fruit fly pest free area (2014)

A fruit fly (Tephritidae) outbreak detected in an FF-PFA may pose a risk for those importing countries where the fruit fly species is considered a quarantine pest. This annex describes control measures to be taken in a fruit fly eradication area established within an FF-PFA in the event of an outbreak.

Corrective actions and other phytosanitary measures that may be used in an eradication area within an FF-PFA are covered by this standard.

The eradication area and the related control measures are established with the intent to eradicate the target fruit fly species and restore FF-PFA status, to protect the surrounding FF-PFA, and to meet the phytosanitary import requirements of the importing country, where applicable. In particular, control measures are needed because movements of regulated articles from and through an eradication area pose a potential risk of spreading the target fruit fly species.

1. Establishment of an Eradication Area

The NPPO of the exporting country should declare an outbreak in accordance with this and other relevant ISPMs (e.g. ISPM 8, ISPM 9, ISPM 17). When a target fruit fly species outbreak is detected within an FF-PFA, an eradication area should be established based on a technical evaluation. The pest free status of the eradication area should be suspended. If control measures cannot be applied to establish an eradication area, then the status of the FF-PFA should be revoked in accordance with this standard.

The eradication area should cover the infested area. In addition, a buffer zone should be established in accordance with this standard, and as determined by delimiting surveys, taking into account the natural dispersal capability of the target fruit fly species, its relevant biological characteristics, and geographical and environmental factors.

A circle delimiting the minimum size of the eradication area should be drawn, centred on the actual target fruit fly species detection and with a radius large enough to comply with the above considerations, as determined by the NPPO of the exporting country. In the case of several pest detections, several (possibly overlapping) circles should be drawn accordingly, as illustrated in Figure 1.

If necessary for the practical implementation of the eradication area, the NPPO of the exporting country may decide to adjust the eradication area to correspond to administrative boundaries or topography, or to approximate the circle with a polygon.

A georeferencing device (e.g. GPS) or map with geographical coordinates may be used for delimiting and enabling recognition of the eradication area. Signposts may be placed along boundaries and on roads to alert the public, and notices may be published to facilitate public awareness.

The NPPO of the exporting country should inform the NPPO of the importing country when a fruit fly outbreak is confirmed and an eradication area is established within an FF-PFA.

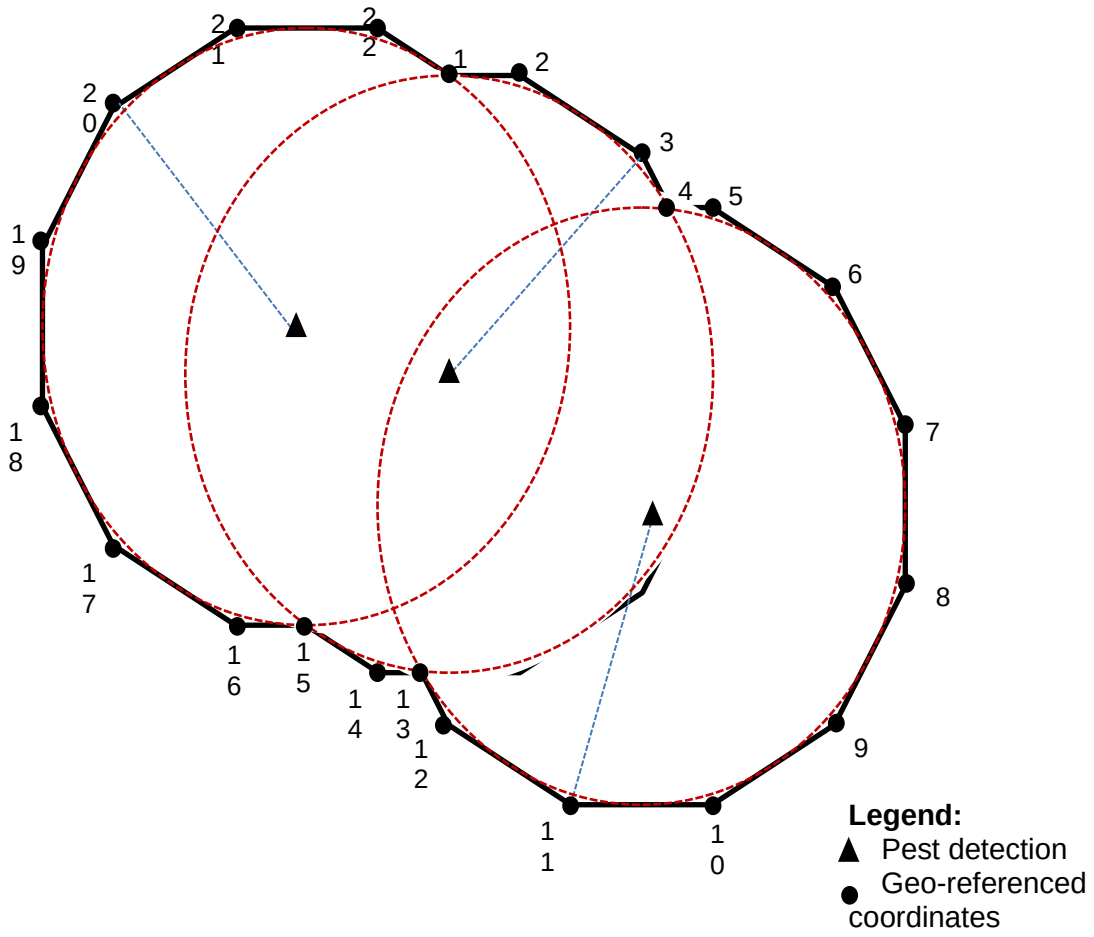

Figure 1. Example of delimiting circles and approximating polygons to determine the eradication area around three pest detections.

2. Control Measures

Each stage of the production chain (e.g. growing, sorting, packing, transporting, dispatching) may lead to spread of the target fruit fly species from the eradication area into the FF-PFA. This statement does not apply to any facilities located in the FF-PFA and handling only host fruit from the FF-PFA. Appropriate control measures should be applied to manage the pest risk for the surrounding FF-PFA and the importing country.

Control measures in use in other fruit fly-infested areas may be implemented in the eradication area.

Control measures may be audited by the NPPO of the importing country, in accordance with the NPPO of the exporting country's requirements.

Control measures applied at each stage of the production chain are described in the following sections.

2.1 Production

During the production period, within the eradication area, the NPPO of the exporting country may require control measures to avoid infestation, such as mechanical and cultural controls, insecticide bait application technique, bait stations, male annihilation technique, mass trapping, sterile insect technique and biological control (details on these control measures are provided in Annex 3 of this standard).

2.2 Movement of regulated articles

Movement of regulated articles (e.g. soil, host plants, host fruit) into, from, through or within the eradication area should comply with control measures to prevent the spread of the target fruit fly species and should be accompanied by the necessary documentation to indicate the articles' origin and destination. This also pertains to moving regulated articles for phytosanitary certification.

2.3 Packing and packing facilities

Fruit packing facilities may be located within or outside the eradication area and may pack host fruit grown in or outside the eradication area. Control measures preventing spread of the target fruit fly species should be taken into account in each case.

The NPPO of the exporting country should:

- register the facility
- require control measures to prevent the target fruit fly species from entering or escaping the facility, as appropriate
- require and approve methods of physical separation of different host fruit lots (e.g. by using insect-proof packaging) to avoid cross-contamination
- require appropriate measures to maintain segregation of host fruits originating from areas of different pest status (e.g. separate locations for reception, processing, storage and dispatch)
- require appropriate measures regarding the handling and movement of host fruit through the facility to prevent mixing of fruit from areas of different pest status (e.g. flowcharts, signs and staff training)
- require and approve methods of disposal of rejected host fruit from the eradication area
- monitor the target fruit fly species at the facility and, if relevant, in the adjacent FF-PFA
- verify the packing material is insect-proof and clean
- require appropriate control measures to eradicate target fruit fly species from the facility when they are detected
- audit the facility.

2.4 Storage and storage facilities

Fruit storage facilities may be located within or outside the eradication area. Such facilities should be registered with the NPPO of the exporting country and comply with the control measures to prevent the spread of the target fruit fly species; for example, they should:

- maintain distinction and separation between host fruit originating from the eradication area and from the FF-PFA
- use an approved method of disposal of host fruit from the eradication area that has been rejected as a result of inspection or quality control activities
- monitor for the target fruit fly species at the facility and if relevant, in the adjacent FF-PFA
- take appropriate control measures to eradicate the target fruit fly species from the facility when detected.

2.5 Processing and processing facilities

If the processing facility is located within the eradication area, host fruit destined for processing (such as juicing, canning and puréeing) does not pose an additional fruit fly risk to the area.

If the facility is located outside the eradication area, the NPPO of the exporting country should require measures within the facility to prevent the escape of the target fruit fly species, through insect-proof reception, storage and processing areas.

Monitoring for the target fruit fly species may be conducted at the facility and, if relevant, in the adjacent FF-PFA. Appropriate control measures should be taken to eradicate target fruit fly species from the facility when they are detected.

Approved disposal of rejected host fruit and plant waste from the eradication area should be required by the NPPO of the exporting country. Rejected host fruit should be disposed of in such a way that the target fruit fly species are rendered non-viable.

2.6 Treatment and treatment facilities

Treatment facilities should be registered by the NPPO of the exporting country.

Post-harvest treatment (e.g. cold treatment, heat treatment, fumigation, irradiation), or in some cases pre-harvest treatment (e.g. bait spray, fruit bagging), may be required for host fruit moving into an FF-PFA or being exported to countries where the target fruit fly species is regulated as a quarantine pest.

Control measures preventing the escape of the target fruit fly species may be required for treatment facilities located within the FF-PFA, if treating regulated articles from the eradication area. The NPPO of the exporting country may require physical isolation within the facility.
The NPPO of the exporting country should approve the method of disposal of rejected host fruit from the eradication area to reduce the risk of spread of the target fruit fly species. Disposal methods may include double bagging followed by deep burial or incineration.

2.7 Sale inside the eradication area

Host fruit sold within the eradication area may be at risk of infestation if exposed before being sold (e.g. placed on display in an open air market) and may therefore need to be physically protected, when feasible, to avoid spread of the target fruit fly species while on display and being stored.

3. Documentation and Record Keeping

The control measures, including corrective actions, used in the eradication area should be adequately documented, reviewed and updated (see also ISPM 4). Such documents should be made available to the NPPO of the importing country on request.

4. Termination of Control Measures in the Eradication Area

Eradication of the target fruit fly species in the eradication area should meet the requirements for reinstatement of an FF-PFA status after an outbreak, according to this standard. The declaration of eradication should be based on no further detections of the target fruit fly species for a period determined by its biology and prevailing environmental conditions, as confirmed by surveillance referred to in this standard.[2]

The control measures should remain in force until eradication is declared. If eradication is successful, the particular control measures in the eradication area may be terminated and the FF-PFA status should be reinstated. If eradication is unsuccessful, the FF-PFA delimitation should be modified accordingly. The NPPO of the importing country should be notified as appropriate.

[2] The period starts from the last detection. For some species, no further detection should occur for at least three life cycles; however, the required period should be based on scientific information, including that provided by the surveillance systems in place.

This annex is a prescriptive part of the standard.

ANNEX 3: Phytosanitary procedures for fruit fly management (2015)

This annex provides guidance for the application of phytosanitary procedures for fruit fly management.

Various phytosanitary procedures are used for fruit fly suppression, containment, eradication and exclusion. These procedures may be applied to establish and maintain FF-PFAs (this standard), and to develop a systems approach for fruit flies, which may include the establishment and maintenance of fruit fly areas of low pest prevalence (FF-ALPPs) (ISPM 35 (*Systems approach for pest risk management of fruit flies (Tephritidae)*)).

The phytosanitary procedures include mechanical and cultural controls, insecticide bait application technique (BAT), bait stations, male annihilation technique (MAT), mass trapping, sterile insect technique (SIT), biological control, and controls on the movement of regulated articles. Many of these procedures can be environmentally friendly alternatives to insecticide application for managing fruit flies.

1. Objectives of Fruit Fly Management Strategies

The four strategies used to manage target fruit fly populations are suppression, containment, eradication and exclusion. One or more of these strategies can be used depending on the circumstances and objectives. The corresponding phytosanitary procedures used for fruit fly management should take into account the phytosanitary import requirements of the importing country, fruit fly status in the target area, hosts, host phenology and host susceptibility, pest biology, and economic and technical feasibility of the available phytosanitary procedures, as relevant.

1.1 Suppression

Suppression strategies may be applied for purposes such as to:

- reduce a target fruit fly population to below an acceptable level
- establish an FF-ALPP (ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*); ISPM 35)
- implement a corrective action in an FF-ALPP when the specified level of low pest prevalence has been exceeded (ISPM 22; ISPM 35)
- reduce a target fruit fly population in order to achieve a specified pest population level that can be used as part of a systems approach (ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*); ISPM 35)
- precede, as part of a process, target fruit fly population eradication in order to establish an FF-PFA (ISPM 4).

1.2 Containment

Containment strategies may be applied for purposes such as to:

- prevent the spread of a target fruit fly from an infested area to an adjacent FF-PFA
- contain an incursion of a target fruit fly into non-infested areas
- protect, as a temporary measure, individual areas where target fruit flies have been eradicated as part of an ongoing eradication programme in a larger area.

1.3 Eradication

Eradication strategies may be applied for purposes such as to:

- eliminate a fruit fly population in order to establish an FF-PFA (ISPM 4)

- eliminate an incursion of a fruit fly species that is a quarantine pest before establishment can occur (this may be part of a corrective action plan in an FF-PFA if the target fruit fly species is detected).

1.4 Exclusion

Exclusion strategies may be applied to prevent the introduction of a fruit fly into an FF-PFA.

2. Requirements for the Application of the Phytosanitary Procedures

The following requirements should be considered when applying phytosanitary procedures for fruit fly management:

2.1 Fruit fly identification capabilities

Accurate identification of the target fruit fly species should be ensured so that the appropriate strategies and phytosanitary procedures can be selected and applied. NPPOs should have access to trained personnel to identify detected specimens of adult and, where possible, immature stages of the target fruit fly species in an expeditious manner (ISPM 6 (*Guidelines for surveillance*)).

2.2 Knowledge of fruit fly biology

The biology of the target fruit fly species should be known in order to determine the appropriate strategy to address its management and select the phytosanitary procedures that will be applied. Basic information on the target fruit fly species may include life cycle, hosts, host sequence, host distribution and abundance, dispersal capacity, geographical distribution and population dynamics. The climatic conditions may also affect the strategy adopted.

2.3 Area delimitation

The area in which the phytosanitary procedures will be applied should be delimited. Geographical characteristics and host distribution within this area should be known.

2.4 Stakeholder participation

Successful implementation of fruit fly phytosanitary procedures requires active and coordinated participation of interested and affected groups, including government, local communities and industry.

2.5 Public awareness

An ongoing public awareness programme should be put in place to inform interested and affected groups about the pest risk and phytosanitary procedures that will be implemented as part of the fruit fly management strategy. Such a programme is most important in areas where the risk of introduction of the target fruit fly species is high. For the success of the management programme it is important to have the support and participation of the public (especially the local community) within the management programme area and of individuals who travel to or through the area.

2.6 Operational plans

An official operational plan that specifies the required phytosanitary procedures should be developed. This operational plan may include specific requirements for the application of phytosanitary procedures and describe the roles and responsibilities of the interested and affected groups (ISPM 4; ISPM 22).

3. Phytosanitary Procedures Used in Fruit Fly Management Strategies

Fruit fly management strategies may involve the use of more than one phytosanitary procedure.

Phytosanitary procedures may be applied in an area, at a place of production or at a production site; during the pre- or post-harvest period; at the packing house; or during shipment or distribution of the commodity. Pest free areas, pest free places of production and pest free production sites may require

the establishment and maintenance of an appropriate buffer zone. Appropriate phytosanitary procedures may be applied in the buffer zone if necessary (this standard and ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*)).

3.1 Mechanical and cultural controls

Mechanical and cultural control procedures may be applied in order to reduce the level of fruit fly populations. These controls include phytosanitary procedures such as orchard and field sanitation, fruit stripping, pruning, host plant removal or netting, fruit bagging, host-free periods, use of resistant varieties, trap cropping, ploughing and ground swamping.

The effectiveness of field sanitation increases when the collection and disposal of fallen fruit are focused on the preferred hosts and are done continuously on an area-wide basis. For good results, collection and disposal should be done before, during and after harvest.

Fruit that remains on the host plants after harvest, fruit rejected because of poor quality during harvest and packing, and fruit on host plants present in the surrounding area should be collected and safely disposed of (e.g. by deep burial).

Elimination or maintaining a low level of vegetation at the place of production will facilitate collection of fallen fruit. In addition, when vegetation is kept low fallen fruit with larvae may be more exposed to direct sunlight and natural enemies, which will contribute to fruit fly larvae mortality.

Bagging of fruit and use of exclusion netting can prevent fruit fly infestation of the fruit. Where used, bagging or exclusion netting should be carried out before the fruit becomes susceptible to fruit fly infestation.

The pupae of many fruit flies can be targeted by disturbing the soil medium in which they pupate. This can be done by ground swamping (causing pupae anoxia) or ploughing (causing physical damage, desiccation to the pupae and exposing them to natural enemies).

3.2 Insecticide bait application technique

BAT uses an appropriate insecticide mixed together with a food bait. Commonly used food baits include attractants such as hydrolysed protein, high-fructose syrup and molasses, used alone or in combination. This technique is an effective control of adult fruit fly populations and reduces the negative impacts on non-target insects and the environment.

Insecticide bait applications should start in time to target maturing adults and to prevent the infestation of fruit. For fruit protection this may be up to three months before the beginning of the harvesting season for fruit intended for export or on detection of the first adult flies or larvae in the field or urban area. Maturing adults should be targeted as this is when protein demands are at their highest. The number of and intervals between applications will depend on the characteristics of the target fruit fly species (biology, abundance, behaviour, distribution, life cycle, etc.), host phenology and weather conditions.

Insecticide baits can be applied from the ground or from the air.

3.2.1 Ground application

Ground application of insecticide bait is usually used for relatively small production areas, such as individual orchards, or in urban areas.

The insecticide bait should generally be applied on or inside the middle to top part of the canopy of host and shelter plants, but specific application should relate to the height of the host plant. For low-growing host plants (e.g. cucurbits, tomatoes, peppers), the insecticide bait should be applied on taller plants surrounding the cultivated area that serve as shelter and a source of food. In FF-PFAs, as part of an emergency action plan to eliminate an outbreak, the insecticide bait can also be applied to non-host plants or other appropriate surfaces around the detection site.

3.2.2 Aerial application

Aerial application of insecticide bait may be used on large production areas and in areas where hosts are scattered in patches over large areas of land. Aerial spraying may be more cost-effective than ground spraying for large-scale programmes, and a more uniform coverage of bait in the target area may be achieved. In some countries, however, aerial spraying may be subject to restrictions due to environmental considerations.

Once the treatment area is selected, it may be defined using a georeferencing device and recorded in digitized maps using GIS software in order to ensure the efficient application of bait sprays and reduce the environmental impact.

To treat the target area, insecticide bait may not need to be applied as full coverage but only in some swathes, such as every second or third swathe. The altitude and speed of aerial application should be adjusted to conditions such as bait viscosity and nozzle specifications, wind velocity, temperature, cloud cover and topography of the terrain.

3.3 Bait stations

Lure and kill devices known as "bait stations" may be a more environmentally friendly control procedure for fruit fly suppression than BAT. Bait stations consist of an attractant and a killing agent that may be contained in a device or directly applied to an appropriate surface. Unlike traps, bait stations do not retain the attracted fruit flies.

Bait stations are suitable for use in, for example, commercial fruit production operations, area-wide fruit fly management programmes, public areas and, in many cases, organic groves. Bait stations may be used in FF-PFAs for population suppression of localized and well-isolated outbreaks. In infested areas known to be fruit fly reservoirs and sources of incursions into FF-ALPPs and FF-PFAs, bait stations should be deployed at high densities.

It is recommended that the attractant used in the bait station be female-biased, thereby directly reducing the overall fruit infestation.

3.4 Male annihilation technique

MAT involves the use of a high density of bait stations consisting of a male lure combined with an insecticide to reduce the male population of target fruit flies to such a low level that mating is unlikely to occur (FAO, 2017).

MAT may be used for the control of those fruit fly species of the genera *Bactrocera* and *Dacus* that are attracted to male lures (cuelure or methyl eugenol). Methyl eugenol is more effective than cuelure for male annihilation of species attracted to these lures.

3.5 Mass trapping

Mass trapping uses trapping systems at a high density to suppress fruit fly populations. In general, mass trapping procedures are the same as for trapping used for survey purposes (Appendix 1 of this standard). Traps should be deployed at the place of production early in the season when the first adult flies move into the field and populations are still at low levels and should be serviced appropriately.

Trap density should be based on such factors as fruit fly density, physiological stage of the fruit fly, efficacy of the attractant and killing agent, phenology of the host and host density. The timing, layout and deployment of traps should be based on the target fruit fly species and host ecological data.

3.6 Sterile insect technique

The SIT is a species-specific environmentally friendly technique that can provide effective control of target fruit fly populations (FAO, 2017).

SIT is effective only at low population levels of the target species and may be used for:

- suppression, where SIT may be a stand-alone phytosanitary procedure or combined with other phytosanitary procedures to achieve and maintain low population levels
- containment, where SIT may be particularly effective in areas that are largely pest free (such as buffer zones) but that are subjected to regular pest entries from adjacent infested areas
- eradication, where SIT may be applied when population levels are low to eradicate the remaining population
- exclusion, where SIT may be applied in endangered areas that are subject to high pest pressure from neighbouring areas.

3.6.1 Sterile fruit fly release

Sterile fruit flies may be released from the ground or from the air. Release intervals should be adjusted according to the longevity of the insect. Sterile fruit flies are generally released once or twice per week but the frequency of release may be influenced by circumstances such as pupae supply, staggered adult fly emergence and unfavourable weather. To establish sterile fruit fly release density, the quality of the sterile fruit flies, the level of the wild population and the desired sterile: wild fruit fly ratio should be considered.

After release of the sterile fruit flies, trapping and identification of the sterile and wild flies should be performed in order to evaluate the effectiveness of the release procedure and also to prevent unnecessary corrective actions. Released sterile flies should be recaptured in the same traps that are used for detection of the wild population as this provides feedback on whether the desired sterile fruit fly density and sterile: wild fly ratio were attained (FAO, 2017).

Ground release may be used when aerial release is neither cost-effective nor efficient (i.e. discontinuous distribution or relatively small area), or where additional releases are required to provide a higher density of fruit flies for a particular reason (e.g. in areas where a specified level of low pest prevalence is exceeded).

Aerial release is more cost-effective than ground release for large-scale programmes and it provides a more uniform sterile fruit fly distribution than ground release, which may clump sterile fruit flies in localized sites or along release routes. Once the release area is selected, it may be defined using a georeferencing device and recorded in digitized maps using GIS software: this will help ensure the efficient distribution of sterile flies. The most common methods for aerial release are chilled adult and paper bag systems (FAO, 2017).

To determine the release altitude, several factors should be considered, including wind velocity, temperature, cloud cover, topography of the terrain, vegetation cover, and whether the target area is urban or rural. Release altitudes range from 200 to 600 m above ground level. However, lower release altitudes should be preferred, especially in areas subjected to strong winds (to prevent excessive sterile fruit fly or bag drift) and in areas where predation by birds is high and frequent. Release in the early morning, when winds and temperature are moderate, is preferable.

3.6.2 Sterile fruit fly quality control

Routine and periodic quality control tests should be carried out to determine the effect of mass rearing, irradiation, handling, shipment duration, holding and release on the performance of the sterile fruit flies, according to desired quality parameters (FAO/IAEA/USDA, 2014).

3.7 Biological control

Classic biological control may be used to reduce fruit fly populations. For further suppression, inundative release may be used. During inundative release, large numbers of natural enemies, typically parasitoids, are mass reared and released during critical periods to reduce pest populations. The use of biological control by inundation is limited to those biological control agents for which mass-rearing technology is available. The mass-reared natural enemies should be of high quality so that suppression

of the target fruit fly population can be effectively achieved. The release of the biological control agents should be directed towards marginal and difficult to access areas that have high host density and that are known to be fruit fly reservoirs and sources of infestation for commercial fruit production or urban areas.

3.8 Controls on the movement of regulated articles

For FF-PFAs, and under certain circumstances for FF-ALPPs, controls on the movement of regulated articles should be implemented to prevent the entry or spread of target fruit fly species (see details in Annex 1 of this standard).

4. Materials Used in the Phytosanitary Procedures

The materials used in the phytosanitary procedures should perform effectively and reliably at an acceptable level for an appropriate period of time. The devices and equipment should maintain their integrity for the intended duration that they are deployed in the field. The attractants and chemicals should be certified or bio-assayed for an acceptable level of performance.

5. Verification and Documentation

The NPPO should verify the effectiveness of the chosen strategies (suppression, containment, eradication and exclusion) and relevant phytosanitary procedures. The main phytosanitary procedure used for verification is adult and larval surveillance, as described in ISPM 6.

NPPOs should ensure that records of information supporting all stages of the suppression, containment, eradication and exclusion strategies are kept for at least 24 months.

6. References

FAO/IAEA (International Atomic Energy Agency)**. 2017.** *Guideline for packing, shipping, holding and release of sterile flies in area-wide fruit fly control programmes*, Second edition, by Zavala-López J.L. and Enkerlin W.R. (eds.). Rome, Italy. 140 pp.

FAO/IAEA (International Atomic Energy Agency)/**USDA** (United States Department of Agriculture)**.** 2014. *Product quality control for sterile mass-reared and released tephritid fruit flies*. Version 6.0. Vienna, IAEA. 164 pp.

This appendix is for reference purposes only and is not a prescriptive part of the standard.

APPENDIX 1: Fruit fly trapping (2011)

This appendix provides detailed information for trapping procedures for fruit fly species (Tephritidae) of economic importance under different pest statuses. Specific traps, in combination with attractants and killing and preserving agents, should be used depending on the technical feasibility, the species of fruit fly and the pest status of the area, which can be an infested area, an FF-ALPP, or an FF-PFA. It describes the most widely used traps, including materials such as trapping devices and attractants, and trap densities, as well as procedures including evaluation, data recording and analysis.

Additional information about fruit fly trapping is available in the following publication of the Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA) (in English only):

FAO/IAEA (International Atomic Energy Agency). 2018. *Trapping guidelines for area-wide fruit fly programmes*, 2nd edn, eds W.R. Enkerlin & J. Reyes-Flores. Rome, FAO. 65 pp. Available at https://www.iaea.org/about/insect-pest-control-section (last accessed 1 October 2018).

Diagnostic protocols adopted as annexes to ISPM 27 (*Diagnostic protocols for regulated pests*) may be useful tools to diagnose the adult fruit fly specimens.

1. Pest Status and Survey Types

There are five pest statuses where surveys may be applied:

A. Pest present without control. The pest is present but not subject to any control measures.

B. Pest present under suppression. The pest is present and subject to control measures. Includes FF-ALPP.

C. Pest present under eradication. The pest is present and subject to control measures. Includes FF-ALPP.

D. Pest absent and FF-PFA being maintained. The pest is absent (e.g. eradicated, no pest records, no longer present) and measures to maintain pest absence are being applied.

E. Pest transient. Pest under surveillance and actionable, under eradication.

The three types of surveys and corresponding objectives are:

- **monitoring surveys**, conducted to verify the characteristics of the pest population
- **delimiting surveys**, conducted to establish the boundaries of an area considered to be infested by or free from the pest
- **detection surveys**, conducted to determine if the pest is present in an area.

Monitoring surveys are necessary to verify the characteristics of the pest population before the initiation or during the application of suppression and eradication measures to verify the population levels and to evaluate the efficacy of the control measures. These surveys are necessary for situations A, B and C. Delimiting surveys are conducted to determine the boundaries of an area considered to be infested by or free from the pest such as boundaries of an established FF-ALPP (situation B) (Annex 1 of ISPM 35) and as part of a corrective action plan when the pest exceeds the established low pest prevalence level or in an FF-PFA (situation E) as part of a corrective action plan when a detection occurs. Detection surveys are conducted to determine if the pest is present in an area, that is, to demonstrate pest absence (situation D) and to detect a possible entry of the pest into the FF-PFA (pest transient, actionable) (ISPM 8 (*Determination of pest status in an area*)).

Additional information on how or when specific types of surveys should be applied can be found in other standards dealing with specific topics such as pest status, eradication, pest free areas or areas of low pest prevalence.

2. Trapping Scenarios

As the pest status may change over time, the type of survey needed may also change:

- Pest present. Starting from an established population with no control (situation A), phytosanitary measures may be applied, and potentially lead to an FF-ALPP (situation B and C) or an FF-PFA (situation D).
- Pest absent. Starting from an FF-PFA (situation D), either the pest status is maintained or a detection occurs (situation E), where measures aimed at restoring the FF-PFA would be applied.

3. Trapping Materials

The effective use of traps relies on the proper combination of trap, attractant and killing agent to attract, capture, kill and preserve the target fruit fly species for effective identification, counting and data analysis. Traps for fruit fly surveys use the following materials, as appropriate:

- a trapping device
- attractants (pheromones, male lures and food attractants)
- killing agents in wet and dry traps (with physical or chemical action)
- preservation agents (wet or dry traps).

3.1 Attractants

Some fruit fly species of economic importance and the attractants commonly used to capture them are presented in Table 1. The presence or absence of a species from this table does not indicate that pest risk analysis has been performed and in no way is presence or absence indicative of the regulatory status of a fruit fly species.

Table 1. A number of fruit fly species of economic importance and commonly used attractants

Species	Attractant
Anastrepha fraterculus (Wiedemann)[4]	Protein attractant (PA)
Anastrepha grandis (Macquart)	PA
Anastrepha ludens (Loew)	PA, 2C-1[1]
Anastrepha obliqua (Macquart)	PA, 2C-1[1]
Anastrepha serpentina (Wiedemann)	PA
Anastrepha striata (Schiner)	PA
Anastrepha suspensa (Loew)	PA, 2C-1[1]
Bactrocera carambolae (Drew & Hancock)	Methyl eugenol (ME)
Bactrocera caryeae (Kapoor)	ME
Bactrocera correcta (Bezzi)	ME
Bactrocera dorsalis (Hendel)[4]	ME, 3C[2]
Bactrocera kandiensis (Drew & Hancock)	ME
Bactrocera musae (Tryon)	ME
Bactrocera occipitalis (Bezzi)	ME
Bactrocera umbrosa (Fabricius)	ME
Bactrocera zonata (Saunders)	ME, 3C[2], ammonium acetate (AA)
Bactrocera cucurbitae (Coquillett)	Cuelure (CUE), 3C[2], AA
Bactrocera neohumeralis (Hardy)	CUE
Bactrocera tau (Walker)	CUE
Bactrocera tryoni (Froggatt)	CUE
Bactrocera minax (Enderlein)	PA
Bactrocera cucumis (French)	PA

Species	Attractant
Bactrocera jarvisi (Tryon)	PA, zingerone
Bactrocera latifrons (Hendel)	PA
Bactrocera oleae (Gmelin)	PA, ammonium bicarbonate (AC), spiroketal (SK)
Bactrocera tsuneonis (Miyake)	PA
Ceratitis capitata (Wiedemann)	Trimedlure (TML), Capilure (CE), PA, 3C[2], 2C-2[3]
Ceratitis cosyra (Walker)	PA, 3C[2], 2C-2[3]
Ceratitis rosa (Karsch)	TML, PA, 3C[2], 2C-2[3]
Dacus ciliatus (Loew)	PA, 3C[2], AA
Myiopardalis pardalina (Bigot)	PA
Rhagoletis cerasi (Linnaeus)	Ammonium salts (AS), AA, AC
Rhagoletis cingulata (Loew)	AS, AA, AC
Rhagoletis indifferens (Curran)	AA, AC
Rhagoletis pomonella (Walsh)	Butyl hexanoate, AS
Toxotrypana curvicauda (Gerstaecker)	2-Methyl-vinylpyrazine

[1] Two-component (2C-1) synthetic food attractant (ammonium acetate and putrescine), mainly for female captures.

[2] Three-component (3C) synthetic food attractant (ammonium acetate, putrescine, trimethylamine), mainly for female captures.

[3] Two-component (2C-2) synthetic food attractant (ammonium acetate and trimethylamine), mainly for female captures.

[4] Taxonomic status of some listed members of the *Bactrocera dorsalis* complex and of *Anastrepha fraterculus* is uncertain.

3.1.1 Male-specific attractants

The most widely used attractants are pheromones or male lures that are male-specific. The male lure trimedlure (TML) captures species of the genus *Ceratitis* (including *C. capitata* and *C. rosa*). The male lure methyl eugenol (ME) captures a large number of species of the genus *Bactrocera* (including *B. carambolae*, *B. dorsalis, B. musae,* and *B. zonata*). The pheromone spiroketal captures *B. oleae*. The male lure cuelure (CUE) captures a large number of other *Bactrocera* species, including *B. cucurbitae* and *B. tryoni*. Male lures are generally highly volatile and can be used with a variety of traps (examples are listed in Table 2a). Controlled-release formulations exist for TML, CUE and ME, providing a longer-lasting attractant for field use. It is important to be aware that some inherent environmental conditions may affect the longevity of pheromone and male lures.

3.1.2 Female-biased attractants

Female-specific pheromones are not usually commercially available (except, for example, 2-methyl-vinylpyrazine). Therefore, the female-biased attractants (natural, synthetic, liquid or dry) that are commonly used are based on food or host odours (Table 2b). Historically, liquid protein attractants (PAs) have been used to capture a wide range of fruit fly species. Liquid PAs capture both females and males. These liquid PAs are generally less sensitive than the male lures. In addition, liquid PAs capture high numbers of non-target insects and require more frequent servicing.

Several food-based synthetic attractants have been developed using ammonia and its derivatives. These may reduce the number of non-target insects captured. For example, for capturing *C. capitata* a synthetic food attractant consisting of three components (ammonium acetate, putrescine and trimethylamine) is used. For capturing *Anastrepha* species the trimethylamine component may be removed. A synthetic attractant lasts approximately four to ten weeks, depending on climatic conditions. It captures few non-target insects and significantly fewer male than female fruit flies, making this attractant suited for use in sterile fruit fly release programmes. New synthetic food attractant technologies are available, including the long-lasting three-component and two-component

mixtures contained in the same patch, as well as the three component mixture incorporated in a single cone-shaped plug.

Because food-foraging female and male fruit flies respond to synthetic food attractants at the sexually immature adult stage, these attractant types are capable of detecting female fruit flies earlier and at lower population levels than liquid PAs.

Table 2a. Attractants and traps for male fruit fly surveys

Fruit fly species	Attractant and trap																									
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs+	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Anastrepha fraterculus																											
Anastrepha ludens																											
Anastrepha obliqua																											
Anastrepha striata																											
Anastrepha suspensa																											
Bactrocera carambolae												x	x	x	x	x	x	x	x								
Bactrocera caryeae												x	x	x	x	x	x	x	x								
Bactrocera minax																											
Bactrocera correcta												x	x	x	x	x	x	x	x								
Bactrocera cucumis																											
Bactrocera cucurbitae																				x	x	x	x	x	x	x	x
Bactrocera dorsalis												x	x	x	x	x	x	x	x								
Bactrocera kandiensis												x	x	x	x	x	x	x	x								
Bactrocera latifrons																											
Bactrocera occipitalis												x	x	x	x	x	x	x	x								
Bactrocera oleae																											
Bactrocera tau																				x	x	x	x	x	x	x	x
Bactrocera tryoni																				x	x	x	x	x	x	x	x
Bactrocera tsuneonis																											
Bactrocera umbrosa												x	x	x	x	x	x	x	x								
Bactrocera zonata												x	x	x	x	x	x	x	x								
Ceratitis capitata		x	x	x	x	x	x	x	x	x	x																
Ceratitis cosyra																											
Ceratitis rosa		x	x	x	x	x	x	x	x	x	x																
Dacus ciliatus																											
Myiopardalis pardalina																											
Rhagoletis cerasi																											
Rhagoletis cingulata																											
Rhagoletis indifferens																											
Rhagoletis pomonella																											

Fruit fly species	Attractant and trap																								
	TML/CE											ME								CUE							
	CC	CH	ET	JT	LT	MM	ST	SE	TP	YP	VARs+	CH	ET	JT	LT	MM	ST	TP	YP	CH	ET	JT	LT	MM	ST	TP	YP
Toxotrypana curvicauda																											

Attractant abbreviations

CE	Capilure
CUE	Cuelure
ME	Methyl eugenol
TML	Trimedlure

Trap abbreviations

CC	Cook and Cunningham trap
CH	ChamP trap
ET	Easy trap
JT	Jackson trap
LT	Lynfield trap
MM	Maghreb-Med or Morocco trap
SE	Sensus trap
ST	Steiner trap
TP	Tephri trap
VARs+	Modified funnel trap
YP	Yellow panel trap

Table 2b. Attractants and traps for female-biased fruit fly surveys

Fruit fly species	**Attractant and trap** (see below for abbreviations)																								
	3C							**2C-2**					**2C-1**	**PA**			**SK+AC**		**AS (AA, AC)**				**BuH**			**MVP**
	ET	SE	MLT	OBDT	LT	MM	TP	ET	MLT	LT	MM	TP	MLT	ET	McP	MLT	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Anastrepha fraterculus															x	x										
Anastrepha grandis															x	x										
Anastrepha ludens													x		x	x										
Anastrepha obliqua													x		x	x										
Anastrepha striata															x	x										
Anastrepha suspensa													x		x	x										
Bactrocera carambolae															x	x										
Bactrocera caryeae															x	x										
Bactrocera minax															x	x										
Bactrocera correcta															x	x										
Bactrocera cucumis															x	x										
Bactrocera cucurbitae			x												x	x										
Bactrocera dorsalis															x	x										
Bactrocera kandiensis															x	x										
Bactrocera latifrons															x	x										
Bactrocera occipitalis															x	x										
Bactrocera oleae														x	x	x	x	x			x	x				
Bactrocera tau															x	x										
Bactrocera tryoni															x	x										
Bactrocera tsuneonis															x	x										
Bactrocera umbrosa															x	x										
Bactrocera zonata			x												x	x										
Ceratitis capitata	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x										
Ceratitis cosyra			x						x						x	x										
Ceratitis rosa		x	x						x						x	x										
Dacus ciliatus			x												x	x										

Fruit fly species	**Attractant and trap** (see below for abbreviations)																								
	3C							**2C-2**					**2C-1**	**PA**			**SK+AC**		**AS (AA, AC)**				**BuH**			**MVP**
	ET	SE	MLT	OBDT	LT	MM	TP	ET	MLT	LT	MM	TP	MLT	ET	McP	MLT	CH	YP	RB	RS	YP	PALz	RS	YP	PALz	GS
Myiopardalis pardalina															x	x										
Rhagoletis cerasi																			x	x	x	x	x	x	x	
Rhagoletis cingulata																					x	x		x	x	
Rhagoletis indifferens																				x	x					
Rhagoletis pomonella																			x		x	x	x			
Toxotrypana curvicauda																										x

Attractant abbreviations

2C-1	(AA+Pt)	BuH	butyl hexanoate
2C-2	(AA+TMA)	MVP	papaya fruit fly pheromone (2-methyl vinylpyrazine)
3C	(AA+Pt+TMA)		
AA	ammonium acetate	PA	protein attractant
AC	ammonium (bi)carbonate	Pt	putrescine
AS	ammonium salts	SK	spiroketal
		TMA	trimethylamine

Trap abbreviations

CH	ChamP trap	MLT	Multilure trap	RS	Red sphere trap
ET	Easy trap	MM	Maghreb-Med or Morocco trap	SE	Sensus trap
GS	Green sphere trap	OBDT	Open bottom dry trap	TP	Tephri trap
LT	Lynfield trap	PALz	Fluorescent yellow sticky “cloak” trap	YP	Yellow panel trap
McP	McPhail trap	RB	Rebell trap		

Table 3. List of attractants and field longevity

Common name	Abbreviation	Formulation	Field longevity[1] (weeks)
Male lures			
Trimedlure	TML	Polymeric plug	4–10
		Laminate	3–6
		Liquid	1–4
		Polyethylene bag	4-5
Methyl eugenol	ME	Polymeric plug	4–10
		Liquid	4–8
Cuelure	CUE	Polymeric plug	4–10
		Liquid	4–8
Capilure (TML plus extenders)	CE	Liquid	12–36
Pheromones			
Papaya fruit fly (*Toxotrypana curvicauda*) (2-methyl-6-vinylpyrazine)	MVP	Patches	4–6
Olive fly (spiroketal)	SK	Polymer	4–6
Food-based attractants			
Torula yeast/borax	PA	Pellet	1–2
Protein derivatives	PA	Liquid	1–2
Ammonium acetate	AA	Patches	4–6
		Liquid	1
		Polymer	2–4
Ammonium (bi)carbonate	AC	Patches	4–6
		Liquid	1
		Polymer	1–4
Ammonium salts	AS	Salt	1
Putrescine	Pt	Patches	6–10
Trimethylamine	TMA	Patches	6–10
Butyl hexanoate	BuH	Vial	2
Ammonium acetate + Putrescine + Trimethylamine	3C (AA+Pt+TMA)	Cone/patches	6–10
Ammonium acetate + Putrescine + Trimethylamine	3C (AA+Pt+TMA)	Long-lasting patches	18–26
Ammonium acetate + Trimethylamine	2C-2 (AA+TMA)	Patches	6–10
Ammonium acetate + Putrescine	2C-1 (AA+Pt)	Patches	6–10
Ammonium acetate / Ammonium carbonate	AA/AC	Polyethylene bag with Aluminium foil cover	3–4

[1] Based on half-life. Attractant longevity is indicative only. Actual timing should be supported by field testing and validation.

3.2 Killing and preserving agents

Traps retain attracted fruit flies through the use of killing and preserving agents. In some dry traps, killing agents are a sticky material or a toxicant. Some organophosphates may act as a repellent at higher doses. The use of insecticides in traps is subject to the registration and approval of the product in the respective national legislation.

In other traps, liquid is the killing agent. When liquid PAs are used, borax to 3% concentration is mixed in to preserve the captured fruit flies. Some PAs are formulated with borax, and thus no additional borax is required. When water is used in hot climates, 10% propylene glycol is added to prevent evaporation of the attractant and to preserve captured flies.

3.3 Commonly used fruit fly traps

This section describes commonly used fruit fly traps. The list of traps is not comprehensive; other types of traps may achieve equivalent results and may be used for fruit fly trapping.

Based on the killing agent, there are three types of traps commonly used:

- **Dry traps.** The fly is caught on a sticky material board or killed by a chemical agent. Some of the most widely used dry traps are Cook and Cunningham (C&C) trap, ChamP (CH) trap, Jackson trap (JT) or Delta trap, Lynfield trap (LT), open bottom dry trap (OBDT) or Phase IV trap, red sphere (RS) trap, Steiner trap (ST), and yellow panel (YP) trap and Rebell (RB) trap.
- **Wet traps.** The fly is captured and drowns in the attractant solution or in water with surfactant. One of the most widely used wet traps is the McPhail (McP) trap. The Harris trap is also a wet trap with a more limited use.
- **Dry or wet traps.** These traps can be used either dry or wet. Some of the most widely used are easy trap (ET), Multilure trap (MLT) and Tephri (TP) trap.

3.3.1 Cook and Cunningham trap

Description

The C&C trap consists of three removable creamy white panels, spaced approximately 2.5 cm apart. The two outer panels are made of rectangular paperboard measuring 22.8 cm × 14.0 cm. One or both panels are coated with sticky material (Figure 1). The adhesive panel has one or more holes that allow air to circulate. The trap is used with a polymeric panel containing an olfactory attractant (usually TML), which is placed between the two outer panels. The polymeric panels come in two sizes – standard and half. The standard panel (15.2 cm × 15.2 cm) contains 20 g TML, while the half size panel (7.6 cm × 15.2 cm) contains 10 g. The entire unit is held together with clips and is suspended in the tree canopy with a wire hanger.

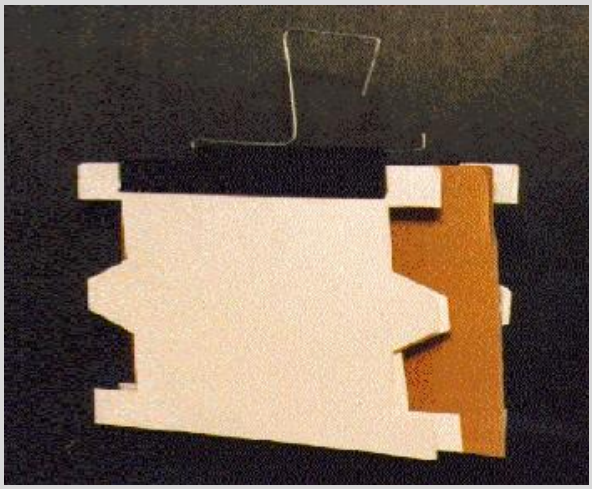

Figure 1. Cook and Cunningham (C&C) trap.

Use

As a result of the need for economical highly sensitive delimiting trapping of *C. capitata*, polymeric panels were developed for the controlled release of greater amounts of TML. These keep the release rate constant for a longer period of time, reducing hand labour and increasing sensitivity. The C&C trap with its multipanel construction has significant adhesive surface area for fly capture.

- For the species for which the trap and attractant is used, see Table 2a.
- For rebaiting (field longevity), see Table 3.

- For use under different scenarios and recommended densities, see Table 4d.

3.3.2 ChamP trap

Description

The CH trap is a hollow, YP-type trap with two perforated sticky side panels. When the two panels are folded, the trap is rectangular in shape (18 cm × 15 cm), and a central chamber is created to place the attractant (Figure 2). A wire hanger placed at the top of the trap is used to place it on branches.

Figure 2. ChamP trap.

Use

The CH trap can accommodate patches, polymeric panels, and plugs. It is equivalent to a YP trap and Rebell trap in sensitivity.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (b and c).

3.3.3 Easy trap

Description

The ET is a two-part rectangular plastic container with an inbuilt hanger. It is 14.5 cm high, 9.5 cm wide and 5 cm deep and can hold 400 ml of solution (Figure 3). The front part is transparent and the rear part is yellow. The transparent front of the trap contrasts with the yellow rear enhancing the trap's ability to catch fruit flies. It combines visual effects with male lure and food-based attractants.

Figure 3. Easy trap.

Use

The trap is multipurpose. It can be used dry baited with male lures (e.g. TML, CUE, ME) or synthetic food attractants (e.g. 3C and both combinations of 2C attractants) and a retention system such as dichlorvos. It can also be used wet baited with liquid PAs, holding up to 400 ml of mixture. When synthetic food attractants are used, one of the dispensers (the one containing putrescine) is attached inside the yellow part of the trap and the other dispensers are left free.

The ET is one of the most economical traps commercially available. It is easy to carry, handle and service, providing the opportunity to service a greater number of traps per person-hour than some other traps.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4d.

3.3.4 Fluorescent yellow sticky "cloak" trap

Description

The fluorescent yellow sticky "cloak" trap (PALz) trap is prepared from fluorescent yellow plastic sheets (36 cm × 23 cm). One side is covered with sticky material. When setting the trap up, the sticky sheet is placed around a vertical branch or a pole in a "cloak-like" manner (Figure 4), with the sticky side facing outward, and the back corners are fastened together with clips.

Figure 4. Fluorescent yellow sticky cloak trap.

Use

The trap uses the optimal combination of visual (fluorescent yellow) and chemical (cherry fruit fly synthetic bait) attractant cues. The trap is kept in place by a piece of wire, attached to the branch or pole. The bait dispenser is fastened to the front top edge of the trap, with the bait hanging in front of the sticky surface. The sticky surface of the trap has a capture capacity of about 500 to 600 fruit flies. Insects attracted by the combined action of these two stimuli are caught on the sticky surface.

- For the species for which the trap and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4e.

3.3.5 Jackson trap or Delta trap

Description

The JT is hollow, delta-shaped and made of a white waxed cardboard. It is 8 cm high, 12.5 cm long and 9 cm wide (Figure 5). Additional parts include a white or yellow rectangular insert of waxed cardboard, which is covered with a thin layer of adhesive used to trap fruit flies once they land inside the trap body; a polymeric plug or cotton wick in a plastic basket or wire holder; and a wire hanger placed at the top of the trap body.

Use

This trap is mainly used with male lures to capture male fruit flies. The attractants used with JT or Delta traps are TML, ME and CUE. When ME and CUE are used a toxicant must be added.

Figure 5. Jackson trap or Delta trap.

For many years this trap has been used in exclusion, suppression or eradication programmes for multiple purposes, including population ecology studies (seasonal abundance, distribution, host sequence, etc.); detection and delimiting trapping; and surveying sterile fruit fly populations in areas subjected to sterile fly mass releases. JT or Delta traps may not be suitable for some environmental conditions (e.g. rain or dust).

The JT or Delta traps are some of the most economical traps commercially available. They are easy to carry, handle and service, providing the opportunity of servicing a greater number of traps per person-hour than some other traps.

- For the species for which the trap and attractant is used, see Table 2a.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (b and d).

3.3.6 Lynfield trap

Description

The conventional LT consists of a disposable, clear plastic, cylindrical container measuring 11.5 cm high with a 10 cm diameter base and 9 cm diameter screw-top lid. There are four entry holes evenly spaced around the wall of the trap (Figure 6). Another version of the LT is the Maghreb-Med trap, also known as the Morocco trap (Figure 7).

Figure 6. Lynfield trap.

Figure 7. Maghreb-Med trap or Morocco trap.

Use

The trap uses an attractant and insecticide system to attract and kill target fruit flies. The screw-top lid is usually colour-coded to the type of attractant being used (red, Capilure (CE)/TML; white, ME; yellow, CUE). To hold the attractant a 2.5 cm screw-tip cup hook (opening squeezed closed) screwed through the lid from above is used. The trap uses the male lures CUE, CE, TML and ME.

CUE and ME attractants, which are ingested by the male fruit fly, are mixed with malathion. However, because CE and TML are not ingested by either *C. capitata* or *C. rosa*, a dichlorvos-impregnated matrix is placed inside the trap to kill fruit flies that enter.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (b and d).

3.3.7 McPhail trap

Description

The conventional McP trap is a transparent glass or plastic pear-shaped invaginated container. The trap is 17.2 cm high and 16.5 cm wide at the base and holds up to 500 ml of solution (Figure 8). The trap parts include a rubber cork or plastic lid that seals the upper part of the trap and a wire hook to hang the trap on tree branches. A plastic version of the McP trap is 18 cm high and 16 cm wide at the base and holds up to 500 ml of solution (Figure 9). The top part is transparent and the base is yellow.

Figure 8. McPhail trap.

Use

For this trap to function properly it is essential that the body stays clean. Some designs have two parts in which the upper part and base of the trap can be separated, allowing for easy rebaiting and inspection of fruit fly captures.

This trap uses a liquid food attractant, based on hydrolysed protein or torula yeast/borax tablets. Torula tablets are more effective than hydrolysed protein over time because the pH is stable at 9.2. The level of pH in the mixture plays an important role in attracting fruit flies. Fewer fruit flies are attracted to the mixture as the pH becomes more acidic.

Figure 9. Plastic McPhail trap.

To bait with yeast tablets, mix three to five torula tablets in 500 ml of water or follow the manufacturer's recommendation. Stir to dissolve the tablets. To bait with protein hydrolysate, mix protein hydrolysate and borax (if not already added to the protein) in water to reach 5–9% hydrolysed protein concentration and 3% borax.

The nature of its attractant means this trap is more effective at catching females. Food attractants are generic by nature, and so McP traps tend to also catch a wide range of other non-target tephritid and non-tephritid fruit flies in addition to the target species.

McP traps are used in fruit fly management programmes in combination with other traps. In areas subjected to suppression and eradication actions, these traps are used mainly to monitor female populations. Female catches are crucial in assessing the amount of sterility induced to a wild population in a sterile insect technique (SIT) programme. In programmes releasing only sterile males or in a male annihilation technique programme, McP traps are used as a population detection tool by targeting feral females, whereas other traps (e.g. JT), used with male-specific attractants, catch the released sterile males, and their use should be limited to programmes with an SIT component. Furthermore, in fruit fly free areas, McP traps are an important part of the non-indigenous fruit fly trapping network because of their capacity to capture fruit fly species of quarantine importance for which no specific attractants exist.

McP traps with liquid PA are labour-intensive. Servicing and rebaiting take time, and the number of traps that can be serviced in a normal working day is half that of some of the other traps described in this appendix.

- For the species for which the trap and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (a, b, d and e).

3.3.8 Modified funnel trap

Description

The modified funnel trap (VARs+) consists of a plastic funnel and a lower catch container (Figure 10). The top roof has a large (5 cm diameter) hole, over which an upper catch container (transparent plastic) is placed.

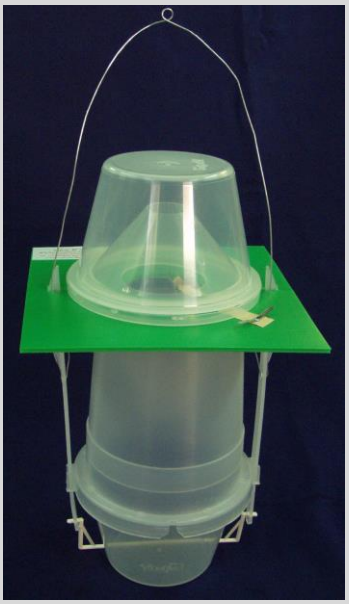

Figure 10. Modified funnel trap.

Use

As it is a non-sticky trap design, it has a virtually unlimited catch capacity and very long field life. The bait is attached to the roof, so that the bait dispenser is positioned in the middle of the large hole on the roof. A small piece of matrix impregnated with a killing agent is placed inside both the upper and the lower catch containers to kill fruit flies that enter.

- For the species for which the trap and attractant is used, see Table 2a.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4d.

3.3.9 Multilure trap

Description

The MLT is a version of the McP trap described previously. The trap is 18 cm high and 15 cm wide at the base and can hold up to 750 ml of solution (Figure 11). It consists of a two-piece plastic invaginated cylindrical container. The top part is transparent and the base is yellow. The upper part and base of the trap separate, allowing the trap to be serviced and rebaited. The transparent upper part of the trap contrasts with the yellow base enhancing the trap's ability to catch fruit flies. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

This trap follows the same principles as those of the McP trap. However, an MLT used with dry synthetic attractant is more efficient and selective than an MLT or McP trap used with liquid PA. Another important difference is that an MLT with a dry synthetic attractant allows for cleaner servicing and is much less labour-intensive than a McP trap. When synthetic food attractants are used, dispensers are attached to the inside walls of the upper cylindrical part of the trap or hung from a clip at the top. For this trap to function properly it is essential that the upper part stays transparent.

Figure 11. Multilure trap.

When the MLT is used as a wet trap a surfactant should be added to the water. In hot climates 10% propylene glycol can be used to decrease water evaporation and decomposition of captured fruit flies.

When the MLT is used as a dry trap, a suitable (non-repellent at the concentration used) insecticide such as dichlorvos or a deltamethrin (DM) strip is placed inside the trap to kill the fruit flies. DM is applied to a polyethylene strip placed on the upper plastic platform inside the trap. Alternatively, DM may be used in a circle of impregnated mosquito net and will retain its

killing effect for at least six months under field conditions. The net must be fixed on the ceiling inside the trap using adhesive material.

- For the species for which the trap and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (a-d).

3.3.10 Open bottom dry trap or Phase IV trap

Description

The OBDT or Phase IV trap is an open-bottom cylindrical dry trap that can be made from opaque green plastic or wax-coated green cardboard. The cylinder is 15.2 cm high and 9 cm in diameter at the top and 10 cm in diameter at the bottom (Figure 12). It has a transparent top, three holes (each of 2.5 cm diameter) equally spaced around the wall of the cylinder midway between the ends, and an open bottom, and is used with a sticky insert. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Figure 12. Open bottom dry trap (Phase IV).

Use

A food-based synthetic chemical female-biased attractant can be used to capture *C. capitata*. However, it also serves to capture males. Synthetic attractants are attached to the inside walls of the cylinder. Servicing is easy because the sticky insert permits easy removal and replacement, similar to the inserts used in the JT. This trap is less expensive than the plastic or glass McP traps.

- For the species for which the trap and attractant is used, see Table 2b.
- For attractants used and rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4d.

3.3.11 Red sphere trap

Description

The RS trap is a red sphere 8 cm in diameter (Figure 13). The trap mimics the size and shape of a ripe apple. A green version of this trap is also used. The trap is covered with a sticky material and baited with the synthetic fruit odour butyl hexanoate, which has a fragrance like a ripe fruit. Attached to the top of the sphere is a wire hanger used to hang it from tree branches.

Figure 13. Red sphere trap.

Use

The red or green traps can be used unbaited, but they are much more efficient in capturing fruit flies when baited. Fruit flies that are sexually mature and ready to lay eggs are attracted to this trap.

Many types of insects will be caught by these traps. It will be necessary to positively identify the target fruit fly from the non-target insects likely to be present on the traps.

- For the species for which the trap and attractant is used, see Table 2b.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4e.

3.3.12 Sensus trap

Description

The Sensus (SE) trap consists of a vertical plastic bucket 12.5 cm high and 11.5 cm in diameter (Figure 14). It has a transparent body and a blue overhanging lid, which has a hole just underneath it. A wire hanger placed on top of the trap body is used to hang the trap from tree branches.

Figure 14. Sensus trap.

Use

The trap is dry and uses male lures or, for female-biased captures, dry synthetic food attractants. A dichlorvos block is placed in the comb on the lid to kill the flies.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4d.

3.3.13 Steiner trap

Description

The ST is a horizontal clear plastic cylinder with openings at each end. The conventional ST is 14.5 cm long and 11 cm in diameter (Figure 15). There are a number of versions of this trap. These include one that is 12 cm long and 10 cm in diameter (Figure 16) and one 14 cm long and 8.5 cm in diameter (Figure 17). A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Figure 15. Conventional Steiner trap.

Figure 16. Steiner trap version.

Figure 17. Steiner trap version.

Use

This trap uses the male lures TML, ME and CUE. The attractant is suspended from the centre of the inside of the trap. The attractant may be a cotton wick soaked in 2-3 ml of a mixture of male lure or a dispenser with the attractant and an insecticide (usually malathion, dibrom or DM) as a killing agent.

- For the species for which the trap and attractant is used, see Table 2a.
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Tables 4 (b and d).

3.3.14 Tephri trap

Description

The TP is similar to the McP trap. It is a vertical cylinder 15 cm high and 12 cm in diameter at the base and can hold up to 450 ml of solution (Figure 18). It has a yellow base and a clear top, which can be separated to facilitate servicing. There are entrance holes around the top of the periphery of the yellow base, and an invaginated opening in

the bottom. Inside the top is a platform to hold attractants. A wire hanger, placed on top of the trap body, is used to hang the trap from tree branches.

Use

The trap is baited with hydrolysed protein at 9% concentration; however, it can also be used with other liquid PAs as described for the conventional glass McP trap or with the female dry synthetic food attractant and with TML in a plug or liquid as described for the JT or Delta trap and YP trap. If the trap is used with liquid PAs or with dry synthetic attractants combined with a liquid retention system and without the side holes, the insecticide will not be necessary. However, when used as a dry trap and with side holes, an insecticide solution (e.g. malathion) soaked into a cotton wick or other killing agent is needed to avoid escape of captured insects. Other suitable insecticides are dichlorvos or DM strips placed inside the trap to kill the fruit flies. DM is applied in a polyethylene strip, placed on the plastic platform inside the top of the trap. Alternatively, DM may be used in a circle of impregnated mosquito net and will retain its killing effect for at least six months under field conditions. The net must be fixed on the ceiling of the inside of the trap using adhesive material.

Figure 18. Tephri trap.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (b and d).

3.3.15 Yellow panel trap and Rebell trap

Description

The YP consists of a yellow rectangular cardboard plate (23 cm × 14 cm) coated with plastic (Figure 19). The rectangle is covered on both sides with a thin layer of sticky material. The RB trap is a three-dimensional YP-type trap with two crossed yellow rectangular plates (15 cm × 20 cm) made of plastic (polypropylene), making them extremely durable (Figure 20). The trap is also coated with a thin layer of sticky material on both sides of both plates. A wire hanger, placed on top of the trap body, is used to hang it from tree branches.

Figure 19. Yellow panel trap.

Use

Figure 20. Rebell trap.

These traps can be used as visual traps alone and baited with TML, spiroketal or ammonium salts (ammonium acetate). The attractants may be contained in controlled-release dispensers such as a polymeric plug. The attractants are attached to the face of the trap. The attractants can also be mixed into the cardboard's coating. The two-dimensional design and greater contact surface make these traps more efficient, in terms of fly captures, than the JT and McP trap. It is important to consider that these traps require special procedures for transportation, submission and fruit fly screening methods because they are so sticky that specimens can be destroyed in handling. Although these traps can be used in most types of control programme applications, their use is recommended for the post-eradication phase and for fruit fly free areas, where highly sensitive traps are required. These traps should not be used in areas subjected to mass release of sterile fruit flies because of the large number of released fruit flies that would be caught. It is important to note that their yellow colour and open design allow them to catch other non-target insects including natural enemies of fruit flies and pollinators.

- For the species for which the trap and attractant is used, see Table 2 (a and b).
- For rebaiting (field longevity), see Table 3.
- For use under different scenarios and recommended densities, see Table 4 (b-e).

4. Trapping Procedures

4.1 Spatial distribution of traps

The spatial distribution of traps will be guided by the purpose of the survey, the intrinsic characteristics of the area, the biological characteristics of the fruit fly and its interactions with its hosts, as well as the efficacy of the attractant and trap. In areas where continuous compact blocks of commercial orchards are present and in urban and suburban areas where hosts exist, traps are usually deployed in a grid system, which may have a uniform distribution.

In areas with scattered commercial orchards, in rural areas with hosts and in marginal areas where hosts exist, trap networks are normally distributed along roads that provide access to host material.

In suppression and eradication programmes, an extensive trapping network should be deployed over the entire area that is subject to surveillance and control actions.

Trapping networks are also placed as part of early detection programmes for target fruit fly species. In this case traps are placed in high-risk areas such as points of entry, fruit markets, urban areas and garbage dumps, as appropriate. Traps in these locations can be supplemented by traps placed along roadsides to form transects and in production areas close to or adjacent to land borders, ports of entry and national roads.

4.2 Trap deployment

Trap deployment involves the actual placement of the traps in the field. One of the most important factors of trap deployment is selecting an appropriate trap site. It is important to have a list of the primary, secondary and occasional fruit fly hosts, and their phenology, distribution and abundance. With this basic information, it is possible to properly place and distribute the traps in the field, and this information also allows for effective planning of a programme of trap relocation.

When possible, pheromone traps should be placed in mating areas. Fruit flies normally mate in the crown of host plants or close by, selecting semi-shaded spots usually on the upwind side of the crown. Other suitable trap sites are the eastern side of the tree, which gets the sunlight in the early hours of the

day, and resting and feeding areas in plants that provide shelter and protect fruit flies from strong winds and predators. In specific situations trap hangers may need to be coated with an appropriate insecticide to prevent ants from eating captured fruit flies.

PA traps should be deployed in shaded areas in host plants. In this case traps should be deployed in primary host plants during their fruit maturation period. In the absence of primary host plants, secondary host plants should be used. In areas with no host plants identified, traps should be deployed in plants that can provide shelter, protection and food to adult fruit flies.

Traps should be deployed in the middle to the top part of the host plant canopy, depending on the height of the host plant, and oriented towards the upwind side. Traps should not be exposed to direct sunlight, strong winds or dust. It is of vital importance to have the trap entrance clear from twigs, leaves and other obstructions such as spider webs to allow proper airflow and easy access for the fruit flies.

Placement of traps in the same tree baited with different attractants should be avoided because it may cause interference among attractants and a reduction of trap efficiency. For example, placing a *C. capitata* male-specific TML trap and a PA trap in the same tree will cause a reduction of female capture in the PA trap because TML acts as a female repellent.

Traps should be relocated following the maturation phenology of the fruit hosts present in the area and biology of the fruit fly species. By relocating the traps it is possible to follow the fruit fly population throughout the year and increase the number of sites being checked for fruit flies.

4.3 Trap mapping

Once traps are deployed at carefully selected sites at the correct density and distributed in an appropriate pattern, the location of the traps must be recorded. It is recommended that the location of traps should be geo-referenced with the use of GPS equipment, where available. A map or sketch of the trap location and the area around the traps should be prepared.

GPS and GIS have proven to be very powerful tools in the management of trapping networks. GPS allows each trap to be geo-referenced through geographical coordinates, which are then used as input information in a GIS.

In addition to GPS location data or in the event that GPS data are not available for trap location, reference for the trap location should include visible landmarks. In the case of traps placed in host plants located in suburban and urban areas, references should include the full address of the property where the traps were placed. Trap reference should be clear enough to allow control teams and supervisors who service the traps to find the trap easily.

A database or trapping book of all traps with their corresponding coordinates should be kept, together with the records of trap services, date of collection, collector, rebaiting, trap captures, and if possible notes on the collection site such as ecological characteristics. GIS provides high-resolution maps showing the exact location of each trap and other valuable information such as exact location of fruit fly detections, historical geographical distribution patterns of the fruit flies, relative size of the populations in given areas and spread of the fruit fly population in case of an outbreak. This information is extremely useful in planning control activities, ensuring that bait sprays and sterile fruit fly releases are accurately placed and cost-effective in their application.

4.4 Trap servicing and inspection

Trap servicing intervals are specific to each trapping system and are based on the half-life of the attractant, noting that actual timings should be supported by field testing and validation (see Table 3). Capturing fruit flies will depend, in part, on how well the trap is serviced. Trap servicing includes rebaiting and maintaining the trap in a clean and appropriate operating condition. Traps should be in a condition to consistently kill and retain in good condition any target flies that have been captured.

Attractants have to be used in the appropriate volumes and at the appropriate concentrations and replaced at the recommended intervals, as indicated by the manufacturer. The release rate of attractants varies considerably with environmental conditions. The release rate is generally high in hot and dry areas, and low in cool and humid areas. Thus, in cool climates traps may have to be rebaited less often than in hot conditions.

Inspection intervals (i.e. checking for fruit fly captures) should be adjusted according to the prevailing environmental conditions, pest situation and biology of fruit flies, on a case-by-case basis. The interval can range from one day up to 30 days, for example, seven days in areas where fruit fly populations are present and 14 days in fruit fly free areas. In the case of delimiting surveys inspection intervals may be more frequent, with two to three days being the most common interval.

It is recommended to avoid handling more than one lure type at a time if more than one lure type is being used at a single locality. Cross-contamination between traps of different attractant types (e.g. CUE and ME) reduces trap efficacy and makes laboratory identification unduly difficult. When changing attractants, it is important to avoid spillage or contamination of the external surface of the trap body or the ground. Attractant spillage or trap contamination would reduce the chance of fruit flies entering the trap. For traps that use a sticky insert to capture fruit flies, it is important to avoid contaminating areas in the trap that are not meant for capturing fruit flies with the sticky material. This also applies to leaves and twigs that surround the trap. Attractants, by their nature, are highly volatile and care should be taken when storing, packaging, handling and disposing of lures to avoid compromising the attractant efficacy and operator safety.

The number of traps serviced per day per person will vary depending on the type of trap, trap density, environmental and topographic conditions and experience of the operators. Where a large trap network is in place, it may need to be serviced over a number of days. In this case, the network may be serviced through a number of “routes” or “runs” that systematically ensure all traps within the network are inspected and serviced and none is missed.

4.5 Trapping records

The following information should be included in proper trapping records that provide confidence in the survey results: trap location, plant where the trap is placed, trap and attractant type, servicing and inspection dates, and target fruit fly capture. Any other information considered necessary can be added to the trapping records. Retaining results over a number of seasons can provide useful information on spatial changes in fruit fly populations.

4.6 Flies per trap per day

Flies per trap per day (FTD) is a population index that indicates the average number of flies of the target species captured per trap per day during a specified period in which the trap was exposed in the field (see also Annex 2 of ISPM 35).

The function of this population index is to have a comparative measure of the size of the adult pest population in a given space and time.

It is used as baseline information to compare the size of the population before, during and after the application of a fruit fly control programme. FTD should be used in all reports of trapping.

FTD is comparable within a programme; however, for meaningful comparisons between programmes, it should be based on the same fruit fly species, trapping system and trap density.

In areas where sterile fruit fly release programmes are in operation FTD is used to measure the relative abundance of the sterile and wild fruit flies.

FTD is the result of dividing the total number of fruit flies captured (F) by the product obtained from multiplying the total number of inspected traps (T) by the average number of days between trap inspections (D). The formula is as follows:

$$FTD = \frac{F}{T \times D}$$

5. Trap Densities

Establishing a trapping density appropriate to the purpose of the survey is critical and underpins confidence in the survey results. Trap density needs to be adjusted based on many factors including type of survey, trap efficiency, location (type and presence of host, climate and topography), pest situation and lure type. In terms of type and presence of host, as well as the risk involved, the following types of location may be of concern:

- production areas
- marginal areas
- urban areas
- points of entry (and other high-risk areas such as fruit markets).

Trap density may also vary as a gradient from production areas to marginal areas, urban areas and points of entry. For example, in a pest free area, a higher density of traps is required at high-risk points of entry and a lower density in commercial orchards. Or, in an area where suppression is applied, such as in an ALPP or an area under a systems approach where the target species is present, the reverse occurs, and trap density for that pest should be higher in the place of production and decrease towards points of entry. Other situations such as high-risk urban areas should be taken into consideration when assessing trapping density.

Table 4 (a–f) shows suggested trap densities for various fruit fly species based on common practice. These densities have been determined taking into consideration research results, feasibility and cost-effectiveness. Trap densities are dependent on associated surveillance activities, such as the type and intensity of fruit sampling to detect immature stages of fruit flies. In cases where trapping surveillance programmes are complemented with fruit sampling activities, trap densities could be lower than the suggested densities shown in Table 4 (a–f).

The suggested trap densities presented in Table 4 (a–f) take into account the following technical factors:

- various survey objectives and pest status
- target fruit fly species (Table 1)
- pest risk associated with working areas (production and other areas).

Within the delimited area, the suggested trap density should be applied in areas with a significant likelihood of capturing fruit flies such as areas with primary hosts and possible pathways (e.g. production areas versus industrial areas).

Table 4a. Trap densities suggested for *Anastrepha* spp.

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	McP/MLT	2C-1/PA	0.25–1.00	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	McP/MLT	2C-1/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	McP/MLT	2C-1/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	McP/MLT	2C-1/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	McP/MLT	2C-1/PA	1–2	2–3	3–5	5–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	McP/MLT	2C-1/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Attractant	
McP	McPhail trap	2C-1	AA+Pt
MLT	Multilure trap	AA	Ammonium acetate
		PA	Protein attractant
		Pt	Putrescine

Table 4b. Trap densities suggested for *Bactrocera* spp. responding to cuelure, methyl eugenol and food attractants

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	0.25–1.00	0.2–0.5	0.2–0.5	0.2–0.5
Monitoring survey for suppression	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	ET/JT/LT/McP/MLT/ MM/ST/TP/YP	CUE/ME/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	ET/JT/LT/McP/MLT/ MM/ST/TP	CUE/ME/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	CH/ET/JT/LT/McP/ MLT/MM/ST/TP/YP	CUE/ME/PA	1	1	1–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	ET/JT/LT/McP/MLT/ MM/ST/TP/YP	CUE/ME/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Attractant	
CH	ChamP trap	CUE	Cuelure
ET	Easy trap	ME	Methyl eugenol
JT	Jackson trap	PA	Protein attractant
LT	Lynfield trap		
McP	McPhail trap		
MLT	Multilure trap		
MM	Maghreb-Med or Morocco trap		
ST	Steiner trap		
TP	Tephri trap		
YP	Yellow panel trap		

Table 4c. Trap densities suggested for *Bactrocera oleae*

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	CH/ET/McP/MLT/YP	AC+SK/PA	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	CH/ET/McP/MLT/YP	AC+SK/PA	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	CH/ET/McP/MLT/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Monitoring survey for eradication	CH/ET/McP/MLT/YP	AC+SK/PA	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	CH/ET/McP/MLT/YP	AC+SK/PA	1	1	2–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	CH/ET/McP/MLT/YP	AC+SK/PA	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Attractant	
CH	ChamP trap	AC	Ammonium bicarbonate
ET	Easy trap	PA	Protein attractant
McP	McPhail trap	SK	Spiroketal
MLT	Multilure trap		
YP	Yellow panel trap		

Table 4d. Trap densities suggested for *Ceratitis* spp.

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control[4]	CH/ET/JT/LT/McP/MLT/OBDT/SE/ST/TP/VARs+	2C-2/3C/CE/PA/TML	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	CH/ET/JT/LT/McP/MLT/MM/OBDT/SE/ST/TP/VARs+	2C-2/3C/CE/PA/TML	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	CH/ET/JT/LT/McP/MLT/MM/OBDT/ST/TP/VARs+/YP	3C/CE/PA/TML	3–5	3–5	3–5	3–5
Monitoring survey for eradication[5]	CH/ET/JT/LT/McP/MLT/MM/OBDT/ST/TP/VARs+	2C-2/3C/CE/PA/TML	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion[5]	CC/CH/ET/JT/LT/McP/MLT/MM/ST/VARs+	3C/CE/PA/TML	1	1–2	1–5	3–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[6]	CH/ET/JT/LT/McP/MLT/MM/OBDT/ST/TP/VARs+/YP	3C/CE/PA/TML	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 1:1 ratio (one female trap per male trap).

[5] 3:1 ratio (three female traps per male trap).

[6] This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones (ratio 5:1; five female traps per male trap).

Trap type		Attractant	
CC	Cook and Cunningham trap (with TML for male capture)	2C-2	(AA+TMA)
CH	ChamP trap	3C	(AA+Pt+TMA)
ET	Easy trap (with 2C and 3C attractants for female-biased captures)	AA	Ammonium acetate
JT	Jackson trap (with TML for male capture)	CE	Capilure
LT	Lynfield trap (with TML for male capture)	PA	Protein attractant
McP	McPhail trap	Pt	Putrescine
MLT	Multilure trap (with 2C and 3C attractants for female-biased captures)	TMA	Trimethylamine
MM	Maghreb-Med or Morocco trap	TML	Trimedlure
OBDT	Open bottom dry trap (with 2C and 3C attractants for female-biased captures)		
SE	Sensus trap (with CE for male captures and with 3C for female-biased captures)		
ST	Steiner trap (with TML for male capture)		
TP	Tephri trap (with 2C and 3C attractants for female-biased captures)		
VARs+	Modified funnel trap		
YP	Yellow panel trap		

Table 4e. Trap densities suggested for *Rhagoletis* spp.

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	PALz/RB/RS/YP	AS/BuH	0.5–1.0	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	PALz/RB/RS/YP	AS/BuH	2–4	1–2	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	PALz/RB/RS/YP	AS/BuH	3–5	3–5	3–5	3–5
Monitoring survey for eradication	PALz/RB/RS/YP	AS/BuH	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	PALz/RB/RS/YP	AS/BuH	1	0.4–3.0	3–5	4–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	PALz/RB/RS/YP	AS/BuH	20–50	20–50	20–50	20–50

[1] Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

[3] Also other high-risk sites.

[4] This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Attractant	
RB	Rebell trap	AS	Ammonium salt
RS	Red sphere trap	BuH	Butyl hexanoate
PALz	Fluorescent yellow sticky “cloak” trap		
YP	Yellow panel trap		

Table 4f. Trap densities suggested for *Toxotrypana curvicauda*

Trapping	Trap type[1]	Attractant	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	GS	MVP	0.25–0.50	0.25–0.50	0.25–0.50	0.25–0.50
Monitoring survey for suppression	GS	MVP	2–4	1	0.25–0.50	0.25–0.50
Delimiting survey in an FF-ALPP after an unexpected increase in population	GS	MVP	3–5	3–5	3–5	3–5
Monitoring survey for eradication	GS	MVP	3–5	3–5	3–5	3–5
Detection survey in an FF-PFA to verify pest absence and for exclusion	GS	MVP	2	2–3	3–6	5–12
Delimiting survey in an FF-PFA after a detection in addition to detection survey[4]	GS	MVP	20–50	20–50	20–50	20–50

1 Different traps can be combined to reach the total number.

(2) Refers to the total number of traps.

3 Also other high-risk sites.

4 This range includes high-density trapping in the immediate area of the detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Attractant	
GS	Green sphere trap	MVP	Papaya fruit fly pheromone (2-methyl-vinylpyrazine)

6. Supervision Activities

Supervision of trapping activities includes assessing the quality of the materials used and reviewing the effectiveness of the use of these materials and trapping procedures.

The materials used should perform effectively and reliably at an acceptable level for a prescribed period of time. The traps themselves should maintain their integrity for the entire duration that they are anticipated to remain in the field. The attractants should be certified or bio-assayed by the manufacturer for an acceptable level of performance based on their anticipated use.

The effectiveness of trapping should be officially reviewed periodically by individuals not directly involved in conducting trapping activities. The timing of review will vary by programme, but it is recommended to occur at least twice a year in programmes that run for six months or longer. The review should address all aspects related to the ability of trapping to detect targeted fruit flies within the time frame required to meet programme outcomes, for example, early detection of a fruit fly entry. Aspects of a review include quality of trapping materials, record-keeping, layout of the trapping network, trap mapping, trap placement, trap condition, trap servicing, trap inspection frequency, and capability for fruit fly identification.

The trap deployment should be evaluated to ensure that the prescribed types and densities of traps are in place. Field confirmation is achieved through inspection of individual routes.

Trap placement should be evaluated for appropriate host selection, trap relocation schedule, height, light penetration, fruit fly access to trap, and proximity to other traps. Host selection, trap relocation and trap proximity to other traps can be evaluated from the records for each trap route. Host selection, trap relocation and trap proximity to other traps can be further evaluated by field examination.

Traps should be evaluated for their overall condition, correct attractant, appropriate trap servicing and inspection intervals, correct identifying markings (such as trap identification and date placed), evidence of contamination and proper warning labels. Evaluation is performed in the field at each site where a trap is placed.

Evaluation of identification capability can occur via target fruit flies that have been marked in some manner in order to distinguish them from wild trapped fruit flies. These marked fruit flies are placed in

traps in order to evaluate the operator's diligence in servicing the traps, competence in recognizing the targeted fruit fly species, and knowledge of the proper reporting procedures once a fruit fly is found. Commonly used marking systems are fluorescent dyes or wing clipping.

In some programmes that survey for eradication or to maintain FF-PFAs, the fruit flies may also be marked by using sterile irradiated fruit flies in order to further reduce the chance of the marked fruit flies being falsely identified as wild fruit flies resulting in unnecessary actions being taken by the programme. A slightly different method is necessary under a sterile fruit fly release programme in order to evaluate personnel on their ability to accurately distinguish target wild fruit flies from the released sterile fruit flies. The marked fruit flies used are sterile and lack fluorescent dye, but are marked physically by wing clipping or some other method. These fruit flies are placed into the trap samples after they have been collected in the field but before they are inspected by the operators.

The review should be summarized in a report detailing how many inspected traps on each route were found to be in compliance with the accepted standards in categories such as trap mapping, placement, condition, and servicing and inspection intervals. Specific recommendations should be made to correct aspects found to be deficient.

Proper record keeping is crucial to the appropriate functioning of trapping. The records for each trap route should be inspected to ensure that they are complete and up to date. Field confirmation can then be used to validate the accuracy of the records. Maintenance of voucher specimens of collected species of regulated fruit fly species is recommended.

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This appendix is for reference purposes only and is not a prescriptive part of the standard.

APPENDIX 2: Fruit sampling

Information about fruit sampling is available in *Fruit sampling guidelines for area-wide fruit fly programmes*, published in 2017 by FAO and the International Atomic Energy Agency (IAEA) (in English only) and available at: https://www.iaea.org/about/insect-pest-control-section.

IPPC Diagnostic protocols adopted as annexes to ISPM 27 (*Diagnostic protocols for regulated pests*) may be useful tools to diagnose the larvae of fruit fly specimens.