



Review of Import Requirements
for fruit fly host produce
from mainland Australia

Biosecurity Technical Group

DEPARTMENT OF PRIMARY INDUSTRIES, PARKS, WATER and ENVIRONMENT

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Review of Tasmanian Import Requirements for fruit fly host produce from mainland Australia

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Comments

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ACRONYMS AND ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ALOP	Appropriate Level of Protection
APPD	Australian Plant Pest Database
APVMA	Australian Pesticides and Veterinary Medicines Authority
AQIS	Australian Quarantine and Inspection Service
BA	Biosecurity Australia
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BTG	Biosecurity Technical Group
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DPIPWE	Department of Primary Industries, Parks, Water and Environment, Tasmania
DQMAWG	Domestic Quarantine Market Access Working Group
FAO	Food and Agriculture Organisation of the United Nations
ICA	Interstate Certification Assurance (Australia)
IRA	Import Risk Analysis
IR	Import Requirements for the importation of plant and plant products into Tasmania, specified in the Plant Quarantine Manual
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NFFWG	National Fruit Fly Working Group
OCPPO	Australian Office of the Chief Plant Protection Officer
PQM	Plant Quarantine Manual
PRA	Pest Risk Analysis
SPS Agreement	World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures
WTO	World Trade Organisation

SUMMARY

Fruit flies are among the most important horticultural pests in the world, rendering a wide range of fruit unfit for sale or consumption. Tasmania is free of pest fruit flies. Entry of host produce to Tasmania has been regulated for many years to support area freedom and maintain export market confidence. Today, the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) administers eighteen fruit fly phytosanitary protocols called Import Requirements. These apply to fruit susceptible to attack by Queensland fruit fly (*Bactrocera tryoni*) and/or Mediterranean fruit fly (*Ceratitis capitata*) - the most significant pest fruit flies in Australia. Unless fruit fly host produce complies with at least one Import Requirement, it is prohibited entry.

Three main factors precipitated this review of fruit fly Import Requirements. These are the routine need to check whether phytosanitary requirements remain fit-for-purpose, observations by Australian regulators that Tasmania's current approach is overly trade restrictive, and recent apparent increases in fruit fly population pressure in south eastern Australia.

Fourteen fruit fly species established in Australia and regarded as economic pests were screened to determine pest potential in Tasmania. Of these, Queensland fruit fly and Mediterranean fruit fly are plausible as quarantine pests for the foreseeable future. Accordingly, a pest risk assessment for each was undertaken. The assessments estimated unrestricted risk – that is, risk was estimated assuming phytosanitary measures are not applied to host produce.

Temperature modelling suggests that the chance of Queensland fruit fly establishment in Tasmania is marginal while those of Mediterranean fruit fly are better. However, as Mediterranean fruit fly is not found outside Western Australia, the volume of potentially infested imported host produce is small compared with that of host produce from the larger eastern Australian range of Queensland fruit fly. These differences mean that on balance, the likelihood of either species entering, establishing and spreading in Tasmania is similar and VERY LOW.

Nonetheless, the consequences of either species could be serious and are estimated as HIGH. Both are iconic pests. Any presence in Tasmania can lead to export trade interruption, as demonstrated by market responses to the first detections of Queensland fruit fly in traps in early 2011. Tasmania's small island economy and reliance on agricultural exports mean the effects of trade disruption are likely to be proportionately greater than those in more economically diverse mainland Australian jurisdictions. In addition, detection in Tasmania of iconic pests has potential to undermine the Tasmanian Brand values that the whole island looks to for product differentiation across a range of sectors.

Hence, the risk posed by Queensland fruit fly and Mediterranean fruit fly was estimated at LOW, which exceeds Tasmania's Appropriate Level of Protection (ALOP)¹, of VERY LOW. This suggests continued phytosanitary measures for imported host produce are warranted. In assessing options, current Import Requirements, except those relating to dimethoate and fenthion, were examined for capacity to lower the risk of each species to VERY LOW.

With adjustment, all Import Requirements can be expected to adequately, but not excessively protect Tasmania against the entry of fruit flies, allowing ALOP to be met. Three new Import Requirements are also proposed. These concern produce irradiation for certain fruits and systems approaches for citrus and strawberries from specific parts of Queensland. Protocols for each have been endorsed in relevant national plant health fora as efficacious for managing the risk of fruit fly in commercial host produce.

The most significant proposed adjustments to current phytosanitary measures are two changes to area freedom specifications. One is a reduction in the trade suspension zone radius around outbreaks in mainland fruit fly free areas - from 80km to 15km or 7.5km for Queensland fruit fly and Mediterranean fruit fly respectively (or double those radii if outbreaks are more than 1km apart). The other is a reduction in the time at which trade without disinfestation can resume (i.e. suspension is lifted) - from 12 months after the last fly is detected in traps or in fruit, to one generation and twenty eight days. The proposed suspension zone specifications are currently accepted by all other Australian jurisdictions.

However, the proposed reduction in trade suspension zone size is conditional for Queensland fruit fly. To take account of the apparent increase in outbreaks in south eastern Australia in the last decade, and given there is nothing to suggest this will not continue, a trap catch threshold is proposed which, if reached, will trigger reversion to an 80km suspension zone. Specifically, if more than 35 male flies are caught within two weeks in permanent plus supplementary traps, produce from within 80km of the outbreak epicentre must be disinfested prior to export to Tasmania.

Actions for verifying the efficacy of the proposed revised and new Import Requirements over the next five years are identified. These actions are intended to inform the next round of review in 2016, but may also prompt earlier revision, as necessary.

¹ Tasmania's Appropriate Level of Protection is expressed as VERY LOW risk

RECOMMENDATIONS

PROPOSED AMENDMENTS TO IMPORT REQUIREMENTS

Recommendation 1: Import Requirement for Area Freedom

Amend Import Requirement 1 for fruit fly Area Freedom to:

- a) Adopt a 15km trade suspension zone for Queensland fruit fly outbreaks in fruit fly free areas when there is either one discovery point or several occurring less than 1km apart, within two weeks. If the trapping rate exceeds 35 male flies within two weeks in permanent plus 16 supplementary Lynfield male-lure traps deployed within 200m of an outbreak discovery point or epicentre, the 15km suspension zone expands to 80km.
- b) Adopt a 30km suspension zone when Queensland fruit flies are detected at outbreak levels at sites more than 1km apart. If the trapping rate exceeds 35 male flies within two weeks in permanent plus 16 supplementary Lynfield male-lure traps deployed within 200m of an outbreak discovery point or epicentre, the 15km suspension zone expands to 80km.
- c) Adopt a 7.5km suspension zone for outbreaks of Mediterranean fruit fly in fruit fly free areas when there is either one discovery point or several occurring less than 1 km apart and within two weeks.
- d) Adopt a 15km suspension zone for Mediterranean fruit fly when outbreak flies are detected at sites more than 1km apart.
- e) Adopt a trade reinstatement period of one generation and twenty-eight days after the last outbreak fly is caught in a trap or the last outbreak larvae is detected, for Queensland fruit fly and Mediterranean fruit fly.

The amended Import Requirement for Area Freedom is at Part Four of this report.

Recommendation 2: Other current Import Requirements

Harmonise Import Requirements for methyl bromide fumigation, cold disinfestation, heat disinfestation and host fruit conditional status with relevant national Interstate Certification Assurance (ICA) protocols.

However, hot water treatment of mangoes should not reflect the corresponding national ICA protocol due to evidence that the treatment schedule is unreliable for disinfestation. A longer hot water treatment schedule is proposed.

The amended Import Requirements for disinfestation and conditional status are at Part Four of this report.

Recommendation 3: National dimethoate and fenthion work

Amend current Import Requirements concerning dimethoate and fenthion, and consider other ICA protocols that currently involve use of these chemicals, pending outcomes of the national review.

PROPOSED NEW IMPORT REQUIREMENTS

Recommendation 4: Irradiation, and systems approaches for strawberries from South East Queensland, and citrus from certain areas of Queensland

Adopt into new Import Requirements, the conditions specified in ICA protocols for irradiation of certain fruit fly host fruit, and for systems approaches for strawberries from South East Queensland, and for citrus from defined areas of Queensland.

The new Import Requirements for irradiation and systems approaches are at Part Four of this report.

MONITORING AND VERIFICATION OF PROPOSED AMENDED IMPORT REQUIREMENTS

Recommendation 5: Fruit fly mainland distribution monitoring

DPIPWE to monitor annually for changes in the mainland distribution of Queensland fruit fly and Mediterranean fruit fly, as well as the thirteen other species listed in the categorisation section of this review. Fruit fly distribution monitoring to include:

- Current distribution of each species, including outbreak frequency and outbreaks in new locations;
- Use or trialling of new lure or other detection technology;
- Results of any new distribution or outbreak modelling;
- Any other mainland fruit fly monitoring and outbreak information, as relevant.

Distribution monitoring reports to be used to inform review of fruit fly Import Requirements in or before 2016.

Recommendation 6: Fruit fly host produce on-arrival inspection

DPIPWE to collate on-arrival inspection results for commercial fruit fly host produce annually. Reports should summarise:

- Results of on-arrival inspection at the current rate of 600 pieces per consignment;
- Type of phytosanitary condition under which host produce was imported;

- Volume and type of host produce and significant changes in either compared with the previous year;
- Mode of certification (i.e. business or government).

On-arrival inspection reports to be used to inform review of fruit fly Import Requirements in or before 2016.

This document comprises four parts.

Part One provides background about Tasmania's regulatory framework for plants and plant products, national fruit fly management and commercial fruit production in Australia. Part One also describes the purpose and scope of the review.

Part Two outlines the method used to review Tasmania's fruit fly Import Requirements. Pest risk analysis guided by relevant international standards is described, consistent with Tasmania's framework for import risk analysis.

Part Three comprises an overview of fruit fly biology and ecology, the pest categorisation, pest risk assessment and analysis of risk mitigation options for species for which risk is estimated to exceed Tasmania's Appropriate Level of Protection.

Part Four proposes revised Import Requirements for fruit fly host produce. It also identifies ways of monitoring ongoing effectiveness of the revised requirements.

PART ONE: INTRODUCTION

1.1 TASMANIAN REGULATION OF IMPORTED PLANTS AND PLANT PRODUCTS

Tasmania has a strong biosecurity culture shaped by its small island nature and a long-standing export focus for its primary industries. This culture is supported by public policy settings that further the aim of minimising harm to Tasmania's environment, economy and people caused by the entry, establishment and spread of pests (DPIW 2007).

Evidence-based analysis is used across all public biosecurity decision-making. Consistent with this, a state framework for import risk analysis was developed which sets out the approach used to evaluate pest risk associated with inbound movement of goods and people, and for formulating sanitary or phytosanitary measures (DPIPWE 2010). The approach aligns with international standards and domestic trade rules that adopt principles established in the World Trade Organisation's *Agreement on the Application of Sanitary and Phytosanitary Measures*. The framework therefore helps Tasmania meet its obligations and exercise its rights for interstate trade regulation. It is available at www.dpipwe.tas.gov.au.

Import risk is gauged against the level of biosecurity risk the Tasmanian Government is prepared to tolerate, given that zero risk is not practically achievable. The acceptable level of risk, known as Tasmania's Appropriate Level of Protection (ALOP), is set at VERY LOW. Imported goods with pest risk at or below VERY LOW do not warrant specific sanitary or phytosanitary measures. However, if risk exceeds VERY LOW, specific measures may be imposed.

Importation of plants and plant products is regulated under Tasmania's *Plant Quarantine Act 1997*. Regulatory measures are set out in Import Requirements, published in the Tasmanian *Plant Quarantine Manual*. Risk analyses used to inform Import Requirements are conducted by the Biosecurity and Plant Health Branch, DPIPWE. Occasionally, import risk analysis working groups are formed under Tasmania's Biosecurity Technical Group (BTG). BTG provides advice to the Tasmanian Biosecurity Committee (TBC), the whole-of-Government body responsible for overseeing the State's biosecurity policy and strategy.

In most cases, the General Manager, Biosecurity and Product Integrity Division, DPIPWE, decides whether measures recommended in an import risk analysis should be given effect as Import Requirements. In some circumstances, the Secretary, DPIPWE, will perform this function, taking into account any advice from BTG and TBC.

1.2 BACKGROUND

1.2.1 NATIONAL MANAGEMENT AND GOVERNANCE ARRANGEMENTS FOR FRUIT FLIES

This review occurs in the context of substantial national activity in fruit fly management. This activity helped initiate the review but also sets limits on it. An outline of national management and decision-making for fruit flies is therefore appropriate.

Impact: Fruit flies are a plant health challenge throughout Australia. Estimates of the cost of fruit flies vary. Sutherst *et al.* (2000) estimated the annual national cost of the native Queensland fruit fly (*Bactrocera tryoni*) at between \$AU25.7million- \$AU49.9million. Other estimates for fruit flies generally are higher and between one to three hundred million dollars per annum (e.g. Lindner & McLeod 2008).

The National Fruit Fly Strategy (NFFS) identifies at least thirteen fruit fly species present in Australia, as high priorities (PHA 2008). Of these, Queensland fruit fly and the introduced Mediterranean fruit fly (*Ceratitidis capitata*) are currently the most significant. Queensland fruit fly, polyphagous² and now endemic along the east coast of the Australian mainland and in some inland areas, accounts for the bulk of costs arising from established fruit flies. Major fruit³ industries affected by Queensland fruit fly include stone fruit, citrus, pome, grape and tomato (Access Economics 2010).

Management: Fruit fly management by horticultural industries and the Commonwealth, State and Northern Territory governments comprises: import regulation; maintenance of fruit fly free areas through host produce movement controls, monitoring and incursion response; surveillance for exotic fruit flies; produce disinfestation; research and community awareness-raising. Between 2003 and 2008, Australia spent nearly \$130 million on fruit fly research, regulation, surveillance, and public awareness (OCPPO 2007).

Governments and industry continue to invest in fruit fly management to the extent that costs are outweighed by production and trade benefits. For example, the Victorian Department of Primary Industries estimated a yearly investment of around \$15 million in a proposed Victorian area-wide Queensland fruit fly management program would result in benefits worth approximately \$33.3 million per annum, comprising \$6.3 million in market access, \$1.4 million in avoided pre-harvest chemical costs and \$25.6 million in avoided disinfestation costs (DPI 2010).

² Feeds on many host species

³ From here on fruit means fruit and fruiting vegetables

All States and the Northern Territory devote public resources to protecting horticulture in areas where Queensland fruit fly and/or Mediterranean fruit fly are not permanently established. The largest of these on the Australian mainland is the Tri-State Fruit Fly Exclusion Zone (FFEZ), jointly managed since 1994 by New South Wales, Victoria and South Australia. Management comprises trapping, outbreak eradication, host produce movement control, and public awareness initiatives.

The FFEZ is recognised as fruit fly free for domestic trade. International trading partners do not regard the entire FFEZ as fruit fly free. Instead, exports are accepted primarily from specific production regions nested within the FFEZ. These are: the Riverland in South Australia; the Riverina in New South Wales; and the Sunraysia, Goulburn Valley and Swan Hill regions in Victoria (OCPPO 2010).

Tasmania is free of pest fruit flies, and protects its horticultural industries through regulation of imported host produce and surveillance. The latter comprises a state-wide trapping network and routine barrier inspection. Produce from any part of Tasmania is recognised as fruit fly free by domestic and international trading partners.

Governance: The priority assigned to fruit fly management in Australia is also reflected in federal governance arrangements. National fruit fly policy development and regulatory standard-setting is undertaken by Plant Health Committee (PHC), chaired by Australia's Chief Plant Protection Officer. All jurisdictions and Plant Health Australia (PHA), the peak national, non-government coordinating body for plant health, are represented at PHC. PHC advises the National Biosecurity Committee on fruit fly matters, which in turn reports to Primary Industries and Natural Resource Management Standing Committees. PHC oversees the Domestic Quarantine Market Access Working Group (DQMAWG) which is charged with developing harmonised, risk-based phytosanitary measures for interstate trade. DQMAWG obtains technical advice from the National Fruit Fly Working Group (NFFWG) convened specifically for this purpose.

Management issues: Tasmania participates at all fruit fly governance levels in the national interest, and to ensure policy development and operational standard-setting recognises this State's particular biosecurity risk profile. The desire to safeguard market access obtained on the back of fruit fly freedom and to protect the State's specific brand values, combined with comparatively greater economic vulnerability, has resulted in Tasmania occasionally taking a more stringent approach to fruit fly host produce import regulation than other States and the Northern Territory.

Area free measures: This applies to arrangements for trade 'suspension zones' around outbreaks in mainland production areas managed to keep fruit fly out, such as the

FFEZ. When an outbreak occurs, a three-part zoning strategy intended to minimise trade disruption while achieving effective outbreak eradication, is implemented. An outbreak zone is established immediately around the infestation. Trade from the outbreak zone is prohibited until eradication is demonstrated. Around the outbreak zone, a suspension zone is created from which fruit may be traded if it is disinfested. Fruit produced outside a suspension zone (but still within the fruit fly free area) remains tradeable without disinfestation. As disinfestation is expensive, the smaller the suspension zone, the less trade-restrictive it is. However, if a suspension zone is too small and fruit fly spreads beyond it, either on the wing or via human carriage of infested produce, infestations in areas outside the suspension zone can occur.

Generally, the size of trade suspension zones (or other pest outbreak buffer zones) is determined by a pest's capacity to move itself from an outbreak area, or be transported out by natural means such as wind, water, insect or other animal vectors. Suspension zone size typically assumes human-assisted movement of the pest out of the outbreak zone can be controlled to a high level. Therefore, suspension zone size is in practice a function of limits to natural dispersal, and confidence in the ability of biosecurity authorities to prevent outward human-assisted movement of pest propagules, infested hosts and host produce. Decisions about suspension zones may also assume the pathway/s that gave rise to an outbreak are or can be controlled, such that the chance of further incursions while eradication is underway, is low. If the chance of additional incursions into a pest free area is not low, for example, because the pest is endemic in areas not far from the area being maintained as pest free, trapping and monitoring arrangements in the suspension zone are particularly critical.

Specifications for establishing and maintaining Fruit Fly Free Areas, including suspension zone arrangements in the event of outbreaks, are articulated in national Codes of Practice (CoPs) for managing Queensland fruit fly (1996 Version 1.1) and Mediterranean fruit fly (Draft). The CoPs were developed by the NFFWG in the mid-1990s to support international market access and facilitate consistent regulation of domestic fruit trade (Anon 1996a, 1996b). Suspension zone size is defined by a 15km radius and a 7.5km radius around Queensland fruit fly and Mediterranean fruit fly outbreaks respectively if there is one discovery point, or several discovery points less than 1km from each other. A 30km radius is applied if there are several discovery points more than 1km apart. Mainland States and the Northern Territory accept these radii for trade out of fruit fly free areas in the event of outbreaks. However, Tasmania does not accept untreated host produce from within 80km of an outbreak of either species.

Suspension zones also have a temporal element to permit resumption of trade without disinfestation when there is evidence that an outbreak has been eradicated. The re-

instatement period for both species is defined in the CoPs as 1 fruit fly generation and 12 days, or 12 weeks, whichever is longer, after the last detection of a fly in the trapping network. Mainland States and the Northern Territory accept this re-instatement period. However, Tasmania does not accept untreated host produce until 12 months after the last fly is trapped.

The additional disinfestation and administrative costs caused by this different stance, along with concern about how the situation is perceived by international trading partners, have prompted calls for Tasmania to better justify its 80km/12 month suspension zone requirements, or else adopt the specifications in the CoPs. Although the CoPs are currently being updated and combined within a single national policy and operational standard for fruit fly management, Tasmania's stance on suspension zone size and period was not directly addressed.

Other measures: As well as area freedom specifications, other phytosanitary options for domestic trade in fruit fly host produce are negotiated through PHC, with DQMAWG developing the technical justifications and operational arrangements for produce certification. In regard to the latter, the Interstate Certification Assurance (ICA) scheme is relevant. The ICA scheme facilitates self-certification by government-accredited businesses, of the phytosanitary status of plants and plant products intended for interstate trade. The ICA scheme provides an alternative to certification by government inspectors. It is a quality assurance based, co-regulatory arrangement, made necessary by the large volume of fresh produce traded in Australia, and practical limits to governments' ability to certify all of it at a reasonable cost to the public.

National phytosanitary protocols based on Hazard Analysis and Critical Control Point (HACCP) principles are developed under the ICA scheme. If a State or the Northern Territory sees merit in an ICA protocol, it may adopt it by formulating an operational procedure and administering accreditation and audit arrangements for those of its own growers or packers who wish to self-certify produce. Jurisdictions can also adopt an ICA protocol by adjusting their import conditions to adopt the phytosanitary measures in the protocol. Importing jurisdictions thus either accept produce from accredited businesses elsewhere in Australia, or from non-accredited businesses which have applied the relevant phytosanitary measures under government supervision.

Twenty-five fruit fly-related ICA protocols have been developed and more are being developed. But, and unlike trade suspension zones, fruit fly ICA acceptance by mainland States and the Northern Territory is not always uniform. Therefore, Tasmania's position on specific ICA protocols is formulated as part of broader and ongoing PHC and DQMAWG deliberation about the level of fruit fly risk mitigation achieved by each protocol.

Dimethoate and fenthion review: These national discussions are currently influenced by imminent reporting by the Australian Pesticides and Veterinary Medicines Authority (APVMA) on its safety review of dimethoate and fenthion. Both chemicals are systemic organophosphates registered for use as pre-harvest sprays or disinfestation treatments for fruit fly. The APVMA appears likely to restrict use of both chemicals, at least for fruit with edible peel. Low chill stone fruit and tomato producers are likely to be most affected due to high reliance on these chemicals for fruit fly control, and as phytosanitary measures.

Recognising the potential impact of the anticipated changes on fruit fly management and trade in host produce, the Chief Plant Protection Officer convenes a national government and industry committee tasked with preparing for the dimethoate and fenthion review outcomes. As part of this effort, an assessment of potential alternative measures for fruit fly management was commissioned to inform industry and regulator responses to a restricted use scenario (Kalang 2010). A small number of options that are not already available were identified, including produce irradiation and systems approaches for summer fruit and tomatoes. ICA protocols for irradiation of a range of tropical fruit and for trade of strawberries from South East Queensland based on a winter-window have been agreed by DQMAWG. However, all other proposed protocols need further development and deliberation.

1.2.2 COMMERCIAL FRUIT PRODUCTION IN AUSTRALIA AND QUALITY ASSURANCE

Commercial fruit production in Australia had a gross value of just under \$4 billion, making it the country's fifth largest agricultural commodity (ABS 2011). Domestically traded fruit is either sold direct to retailers or through the wholesale system. Main wholesale markets are in Brisbane, Sydney, Adelaide and Melbourne.

Most commercially produced fresh fruit consigned to Tasmania arrives via the Melbourne Market where it is often split from larger consignments destined for Victorian consumers. Estimates (Port of Melbourne unpublished data), indicate commercial fruit imports to Tasmania are around 25 000 tonnes per annum, with an approximate value of \$40 million (DPIPWE 2008). Hence, the Tasmanian market for mainland fruit, while small compared to more populous States, nonetheless draws in a sizeable volume of fruit fly host produce.

The chance of fruit fly presence in commercially traded fruit is influenced by quality management. Consistent with global trends since the early 1990s, adoption by domestic horticultural sectors of quality assurance systems has been necessary to meet increasing consumer demands (Wills *et al.* 2007). Today quality assurance using HACCP is common. Pest presence in fruit is one hazard managed through this process.

In Australia, Freshcare is the leading HACCP-based on-farm quality assurance program for horticulture with around 5000 members. It is based on Codes of Practice intended to ensure fresh produce is safe to eat, meets customer specifications and regulatory requirements, and is grown with due consideration for the environment (see www.freshcare.com.au). Fruit grading and packing businesses operate under the SQF2000 system to meet the quality specifications of major supermarkets. Quality parameters for commercially produced fresh fruit are wide-ranging. Several criteria influence fruit marketability (e.g. appearance, mouth feel, flavour, nutritional value and defects). All are affected by fruit fly larval infestation.

Increasing consumer concern about how food is produced, especially from food safety and sustainable production perspectives, means that quality criteria other than how fruit looks or tastes, are also important. Hence, there is increasing interest among fruit growers in Integrated Pest and Disease Management (IPDM), primarily to foster a more discriminating and sustainable approach to pesticide use (Kalang 2010).

Fruit fly management or phytosanitary measures involving in-field chemical spraying may compromise IPDM programs by, for example, eliminating beneficial organisms. Other fruit fly management options that are less likely to affect IPDM include reduced spray schedules, field hygiene, physical removal of alternative hosts, using mulch and trickle irrigation to minimise free-standing water, fruit inspection at harvest, grading and packing (Kalang 2010) and use of winter windows when fruit fly population pressure is likely to be lower.

No single management measure of the type outlined above is likely to safeguard adequately against presence of fruit fly in fruit traded out of endemic areas. This issue may be addressed by using a combination of measures to give adequate confidence that fruit fly larvae are not in fruit. Use of practices such as those outlined above within an integrated quality management system can be expected to reduce the likelihood of fruit fly presence in commercial fruit from areas that are not fruit fly free. However, how much risk mitigation is achieved, compared with fruit not produced under a quality management system, is difficult to gauge with precision. While there is economic incentive for high levels of compliance with quality assurance schemes, not all mainland fruit exporters use them, or use them reliably for biosecurity purposes. Hence, judgements about risk mitigation achieved by quality assurance systems need to be conservative.

1.3 RATIONALE AND SCOPE

Entry of fresh fruit that is susceptible to fruit fly infestation is prohibited in Tasmania unless importers can demonstrate compliance with one of eighteen Import Requirements listed in Table 1. The Import Requirements are grouped according to seven types of phytosanitary measure. These are:

- Area freedom
- Treatment with dimethoate
- Treatment with fenthion
- Treatment with methyl bromide
- Cold treatment
- Heat treatment
- Conditional status

Table 1 - Tasmanian import requirements for fruit fly host produce

Import Requirement	Title
1	Area Freedom for Queensland Fruit Fly (<i>Bactrocera tryoni</i> (Froggatt)) and Mediterranean Fruit Fly (<i>Ceratitis capitata</i> (Wiedemann))
2A	Treatment with Dimethoate (400 ppm and 200 ppm) FOR Qfly
2B	Treatment with Fenthion (412.5 ppm) for Qfly
3A	Treatment with Fenthion (500 ppm) for Medfly (Tamarillo fruit)
3B	Treatment with Fenthion (412.5 ppm) for Medfly (Tomato fruit)
3C	Treatment With Fenthion (412.5 ppm) for Medfly (Mango and Capsicum fruit)
4A	Fumigation with Methyl Bromide (Qfly, Medfly)
4B	Methyl Bromide Fumigation Plus Cold Treatment For Qfly (Avocado fruit)
5	Cold Sterilisation (Qfly, Medfly)
6A	Heat Treatment for Qfly and Medfly (Avocado fruit)
6B	Heat Treatment for Qfly (Mango fruit)
6C	Heat Treatment for Qfly (Papaya/Papaw/Pawpaw Fruit)
7A	Condition or Maturity for Qfly (Hard Green Condition Papaya and Banana fruit)
7B	Condition or Maturity for Qfly (Mature Green Condition Tomato, Babaco, Banana, Black Sapote, Papaya, Passionfruit, Tahitian Lime fruit)
7C	Condition or Maturity for Qfly (Unbroken Skin Mangosteen, Lychee, Longan, Rambutan fruit)
8A	Condition or Maturity for Medfly (Hard Green Condition Banana fruit)
8B	Condition or Maturity for Medfly (Mature Green Condition Banana and Tomato fruit)
8C	Hard Green Condition for Medfly (Avocado fruit)

In 2008 the Tasmanian Biosecurity Technical Group (BTG) agreed to review the State's Import Requirements for fruit fly host produce from the Australian mainland.

Three main factors brought the matter of fruit fly import risk before BTG. These were:

- *Need for routine review:* Importation of fruit fly host produce has been regulated by successive Tasmanian governments for many years. However, the Import Requirements have not been systematically reviewed, in particular against Tasmania's Appropriate Level of Protection (ALOP); and

- *Predictions over at least the last decade (e.g. Sutherst et al. 2000) that the southern range of Queensland fruit fly will progressively extend as warmer conditions support more generations per year and reduced winter mortality:* The high number of Queensland fruit fly outbreaks in eastern mainland Australia in 2001, 2008 and 2010 and recent overwintering populations in southern Victoria, support these predictions and suggest the level of risk posed by Queensland fruit fly to Tasmania may be changing; and
- *Observations in national fora that the Tasmanian Government's approach to regulation of fruit fly host produce from mainland fruit fly free areas is more trade-restrictive than necessary compared with measures imposed by other Australian States and the Northern Territory:* This applies particularly to the part of Import Requirement 1 that specifies fruit cannot be imported from within 80km of any outbreak in a mainland fruit fly free area without disinfestation, and that trade suspension operates for 12 months after the last fly is trapped.

Accordingly, BTG formed a Working Group to conduct the review.

The purpose of the review is to determine whether each Import Requirement for fruit fly host produce remains fit-for-purpose. To make these determinations, the risk posed to the whole of Tasmania by fruit flies associated with host fruit from anywhere on the Australian mainland is evaluated.

Import Requirements 2A, 2B, 3A, 3B and 3C are excluded from the review because decision-making about use of dimethoate and fenthion for phytosanitary purposes is subject to national processes which include safety appraisal and deliberation on alternatives to both chemicals. At the time of writing, national work was not sufficiently advanced to inform this review in regard to the five Import Requirements. As fruit trade in Australia is highly nationalised and Tasmania, by virtue of its small population, is not a major market, there is little value in pre-empting the outcomes of national work. Consequently, review of the five Import Requirements is deferred, subject to completion of that work.

The review is limited to fresh, commercially produced, undamaged, trash-free fruit intended for distribution and human consumption anywhere in Tasmania. The review excludes dried fruit because it presents negligible fruit fly risk. It also excludes soil, foliage and other plant trash, and fruit fly host plants. These materials are either prohibited entry or subject to different Import Requirements.

Similarly, home-grown and other forms of non-commercially produced fruit are excluded from the review because the chance of fruit fly infestation is likely to vary widely compared with commercially produced fruit, making assessment on anything but a case-by-case basis impossible. Non-commercially produced host fruit remains prohibited entry to Tasmania, unless importers can demonstrate the fruit meets Tasmania's ALOP.

The Import Requirements apply to host fruit of Queensland fruit fly and/or Mediterranean fruit fly, both of which belong to the Family Tephritidae. The review also considers thirteen additional tephritid fruit flies that are present in Australia and identified as economic pests, either through listing in the National Fruit Fly Strategy or in White & Elson-Harris (1992).

The review examines fruit flies in the context of contemporary commercial fruit production in Australia, quality objectives of which are taken into account in pest risk assessment. Otherwise, risk for imported host produce is assessed assuming no specific pre-barrier phytosanitary measures for fruit fly are in place.

The period for which fruit fly risk is estimated is the five years to 2016, at which time any decisions made about import measures as a result of this review should be revisited. This does not preclude earlier review, should that become necessary.

PART TWO: METHOD

The review is undertaken using a method for pest risk analysis consistent with Tasmania's import risk analysis framework (DPIPWE 2010) and guided by the relevant International Plant Protection Convention (IPPC) standards. These are primarily the International Standard for Phytosanitary Measures (ISPM), 2: *Framework for pest risk analysis* (FAO 2009) and ISPM 11: *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms* (FAO 2009). Terms used are in accord with ISPM 5: *Glossary of phytosanitary terms* (FAO 2009).

ISPM 11 describes a three-stage approach to pest risk analysis comprising:

- Initiation
- Pest risk assessment
- Pest risk management

2.1 INITIATION

Initiation is the problem definition stage of pest risk analysis. It involves clarifying the rationale and context for the analysis, and establishing its bounds, particularly in regard to the pests and pathways to be examined, and the area for which pest risk is to be assessed. Initiation involves identifying relevant existing risk mitigation and clarifying the period for which risk is estimated.

Initiation of this review of fruit fly Import Requirements is described in Section 1.2.

2.2 PEST RISK ASSESSMENT

Pest risk assessment is a two-tiered procedure that separates pests for which phytosanitary measures are justified from those for which they are not. The first tier, known as pest categorisation, identifies and removes from further assessment, organisms that do not satisfy the IPPC definition of 'quarantine pest'. Remaining organisms are categorised as potential quarantine pests, and pass to the second tier of assessment which involves:

- estimating the likelihood of entry, establishment and spread of the potential pest;
- estimating the magnitude of biological and economic consequences in the event the potential pest enters, establishes and spreads in the manner anticipated by the likelihood assessment;
- combining likelihood and consequence estimates to yield a risk estimate that is used to decide whether risk posed by the pest is acceptable or not.

2.2.1 PEST CATEGORISATION

Pest categorisation is a screening exercise applied to the pool of organisms identified in the initiation stage as relevant to the import question. In this review, pest categorisation

sorted fifteen fruit fly species into those that warrant further assessment and those that do not, according to four criteria. The former are known as ‘categorised pests’. The criteria are:

- presence or absence in Tasmania;
- association with imported commercial grade fruit;
- potential for establishment and spread in Tasmania;
- potential for consequences in Tasmania.

The criteria were applied according to the sequence above and if one was assessed as implausible, subsequent criteria were not assessed. In addition, if there was significant doubt about whether a fruit fly species could meet any criterion, it was assumed to be plausible.

2.2.2 LIKELIHOOD OF ENTRY, ESTABLISHMENT AND SPREAD

The likelihood that an organism categorised as warranting further assessment will enter, establish and spread in Tasmania is estimated by considering biological, ecological and other factors relevant to each of those potential events. Entry is considered in two parts. For situations involving a host produce pathway, factors influencing the chance of infested produce passing the quarantine barrier are considered, such as routine in-field, packhouse, handling, storage, transport and on-arrival procedures. Factors influencing the chance of imported infested produce being distributed in the vicinity of hosts in Tasmania are also considered. Likelihood of entry is estimated taking into account importation and distribution pathways.

Likelihood is qualitatively described using the six categories in Table 2. The indicative probability ranges for each likelihood category guide and facilitate broad consistency in interpretation. The probability ranges are not precise quantitative expressions of the chance that entry, establishment or spread will occur.

Table 2 – Nomenclature for qualitative likelihoods

Likelihood (L)	Description	Indicative probability range
High	Very likely to occur	0.7 < P ≤ 1 At least 70% chance of occurring
Moderate	Even possibility of occurrence	0.3 < P ≤ 0.7 Between 70% and 30% chance of occurring
Low	Unlikely to occur	0.05 < P ≤ 0.3 Between 30% and a one in twenty chance of occurring
Very Low	Very unlikely to occur	0.01 < P ≤ 0.05 Between a one in twenty and a one in a thousand chance of occurring
Extremely Low	Extremely unlikely to occur	0.01 < P ≤ 0.001 Between a one in a thousand and one in a million chance of occurring
Negligible	Almost certainly would not occur	0 ≤ P ≤ 0.000001 Less than one in a million chance of occurring

For each categorised species of fruit fly, likelihoods for entry, establishment and spread were assessed discretely, and subsequently combined to give an overall likelihood estimate called L(EES). L(EES) was obtained by combining the three discreet likelihood estimates according to the scheme in Table 3.

Table 3 - Rules for combining qualitative likelihoods

	High	Moderate	Low	Very Low	Extremely Low	Negligible
High	High	Moderate	Low	Very Low	Extremely low	Negligible
Moderate		Low	Low	Very Low	Extremely low	Negligible
Low			Very Low	Very Low	Extremely low	Negligible
Very Low				Extremely low	Extremely low	Negligible
Extremely Low					Negligible	Negligible
Negligible						Negligible

2.2.3 MAGNITUDE OF POTENTIAL CONSEQUENCES

The types of potential direct and indirect economic, environmental and social impacts of each fruit fly were identified consistent with criteria established in ISPM 11.

Subsequently, and since Tasmanian fruit industries are located state-wide, the likely magnitude of each kind of impact was described at state and regional scales and over the next five year period, according to the following:

- **indiscernible** - impact not usually distinguishable from normal day-to-day variation, or unlikely to be noticeable. The magnitude of consequence at a state scale is LOW or less;
- **minor significance** - impact not expected to threaten economic viability, but could lead to minor increases in mortality/morbidity or minor decreases in production or minor trade disruption. For environmental or social amenity criteria, impact is not expected to threaten intrinsic values, though value would be considered 'disturbed'. Effects generally expected to be reversible and recovery achievable, including in the short term. The magnitude of consequence at a state scale is MODERATE;
- **significant** - impact could threaten economic viability through a moderate increase in mortality/morbidity, or a moderate decrease in production, or moderate trade disruption. For environmental or social amenity criteria, intrinsic value could be significantly diminished, or threatened. Effects may not be reversible and recovery may not be achievable in the short term. The magnitude of consequence at a state scale is HIGH;

- **highly significant** - impact could threaten economic viability through a large increase in mortality/morbidity, or a large decrease in production, and major trade disruption. For environmental or social amenity criteria, intrinsic values could be severely damaged. Effects are probably irreversible and recovery is likely to take many years. The magnitude of consequence at a state scale is EXTREME.

The descriptive ratings were assigned a letter score using the schema in Table 4.

Table 4 - Magnitude of regional and state consequences

Impact Score	Region	State
G	Highly significant	Highly significant
F	Highly significant	Significant
E	Significant	Minor
D	Minor	Indiscernible
C	Indiscernible	Indiscernible
B	Indiscernible	Indiscernible
A	Indiscernible	Indiscernible

The letter scores for each type of impact were aggregated according to the following mutually exclusive rules:

- If any impact is G or more than one impact is F, or one impact is F and the rest are E, the overall magnitude of consequences is EXTREME;
- If any impact is F or all impacts are E, the overall magnitude of consequences is HIGH;
- If any impact is E or all impacts are D, the overall magnitude of consequences is MODERATE;
- If any impact is D or all impacts are C, the overall magnitude of consequences is LOW;
- If impact is C or all impacts are B, the overall magnitude of consequences is VERY LOW;
- If one or more impacts are B and the rest are A, or all impacts are A, the overall magnitude of consequences is NEGLIGIBLE.

2.2.4 RISK ESTIMATION

Risk was estimated for each fruit fly species with reference to the matrix of risk categories in Table 5 which combines each overall L(EES) with the corresponding overall consequence estimate. The resulting risk estimate is described as 'unrestricted', because it was made assuming no specific phytosanitary measures for fruit are applied.

The band of cells in the matrix designated 'very low' risk indicates Tasmania's Appropriate Level of Protection (ALOP) against which the estimated risk for each of the fruit flies was compared.

Risk estimates that fell at or below ‘very low’ indicated ALOP is met in the absence of specific phytosanitary measures. Unrestricted risk estimates that fell above ‘very low’ indicate ALOP is not met and that evaluation of specific import risk management measures was necessary.

Table 5 - Risk estimation matrix

Likelihood of entry, establishment and spread	<i>High</i>	Negligible risk	Very low Risk	Low risk	Moderate risk	High risk	Extreme risk
	<i>Moderate</i>	Negligible risk	Very low Risk	Low risk	Moderate risk	High risk	Extreme risk
	<i>Low</i>	Negligible risk	Negligible Risk	Very low risk	Low risk	Moderate risk	High risk
	<i>Very low</i>	Negligible risk	Negligible Risk	Negligible risk	Very low risk	Low risk	Moderate risk
	<i>Extremely low</i>	Negligible risk	Negligible Risk	Negligible risk	Negligible risk	Very low risk	Low risk
	<i>Negligible</i>	Negligible risk	Negligible Risk	Negligible risk	Negligible risk	Negligible risk	Very low risk
		<i>Negligible</i>	<i>Very low</i>	<i>Low</i>	<i>Moderate</i>	<i>High</i>	<i>Extreme</i>

Magnitude of Consequences

2.3 RISK MANAGEMENT

2.3.1 IDENTIFICATION AND EVALUATION OF PHYTOSANITARY MEASURES

Risk management includes identifying and evaluating phytosanitary measures for reducing unrestricted risk to ‘very low’. In addition, options are selected which are feasible, cost effective and least trade-restrictive.

For this review, consideration of phytosanitary measures was limited to those assembled in current Import Requirements and any new protocols agreed by the DQMAWG. However, current Import Requirements and any additional ICA protocols concerning dimethoate and fenthion, were excluded from the review due to the APVMA situation.

The effect of each set of measures on the likelihood of fruit flies entering Tasmania in host produce was assessed, taking into account relevant biological and other factors. The Import Requirements were also examined for alignment with corresponding ICA protocols. Alignment, if justifiable on technical and operational bases, was considered to be a means of achieving feasible, least trade-restrictive and cost-effective measures.

The unrestricted risk estimate for each fruit fly was ‘recalculated’ using the revised entry likelihood to determine whether ALOP would be met if the measures are applied.

2.3.2 VERIFICATION OF PHYTOSANITARY MEASURES

Estimating unrestricted risk and the reduction in risk achieved by phytosanitary measures invariably involves various types of uncertainty that may have minor or major implications for the reliability of decisions about how to manage risk. In addition, risk changes over time. Thus, practical means of monitoring and verifying the effectiveness and appropriateness of phytosanitary measures or over time is prudent. Monitoring and verification measures are identified.

PART THREE: PEST RISK ASSESSMENT

3.1 BIOLOGY AND ECOLOGY OF THE TEPHRITIDAE (FRUIT FLIES)

3.1.1 TEPHRITID PEST STATUS AND TAXONOMY

The family Tephritidae is cosmopolitan, containing around 4000 fruit fly species and 500 genera (White & Elson-Harris 1992). Over 98% of species are not economically important but pest Tephritidae occur in almost all fruit growing areas worldwide.

Larvae of most fruit flies develop in flowers or fruit of wild and cultivated plants (White & Elson-Harris 1992), and several species are also easily transported in fruit as eggs or larvae. Consequently, many species of Tephritidae are recognised nationally and internationally as horticultural and quarantine pests. The CAB International Crop Protection Compendium lists more than 50 fruit fly species as pests (CABI 2007). Some countries regulate all tephritids.

Australia's National Fruit Fly Strategy (NFFS) identifies forty-three tephritid species as high priority threats to horticulture. Thirteen are established in some part of the country (PHA 2008). While no recognised pest species are established in Tasmania, some tephritids are known to occur, most commonly belonging to the Tephritinae. These lay eggs on plants of the family Asteraceae (daisies) and are not fruit pests.

The family Tephritidae is divided into subfamilies, of which the Ceratitidinae, Dacinae and Trypetinae (Hancock *et al.* 2000) are most economically important. At a global level, fruit flies of greatest economic significance within the three subfamilies belong to the following genera:

- *Anastrepha* species (Trypetinae) occur in South and Central America and the Caribbean;
- *Rhagoletis* species (Trypetinae) occur in South and Central America temperate areas of North America and Europe;
- *Dirioxa* species (Trypetinae) are present in Australia;
- *Ceratitis* species (Ceratitidinae) and *Dacus* species (Dacinae) are native to tropical Africa. One *Ceratitis* species is established in Australia;
- *Bactrocera* species (Dacinae) are native to tropical Asia, Australia and the South Pacific.

There are approximately 80 native species of dacine Tephritidae in Australia (Drew 1989), most belonging to the genus *Bactrocera*. The most notable non-*Bactrocera* species in Australia is the introduced Mediterranean fruit fly (*Ceratitis capitata*) of subfamily Ceratitidinae. The Ceratitidinae are sometimes treated as a subgroup of the

Dacinae. For this review, Mediterranean fruit fly is treated with the dacine fruit flies unless it differs significantly.

3.1.2 GENERAL FRUIT FLY LIFE CYCLE

In a review of dacine fruit flies, Fletcher (1987) noted that most have a similar life cycle comprising four stages: egg, larvae, pupae and adult.

In economically significant species, females lay eggs beneath the skin of ripening host fruit using a telescopic tube called an ovipositor (White & Elson-Harris 1992). Larvae hatch out into the fruit and undergo three developmental stages, or instars. Unless picked, fruit containing larvae generally fall to the ground and the third instar exit to pupate in the soil (Fletcher, 1987). The skin of the final instar becomes a hard capsule called a puparium. Within this protective structure, the pupa transforms into the adult form.

The unemerged adult is sensitive to ambient temperature, a condition that provides for acclimatisation before it leaves the puparium. On emerging, the priority for adults is to locate shelter, water and food, particularly dietary protein. These resources are necessary for emergent adults to mature sexually, find mates and initiate the next generation.

3.1.3 ENVIRONMENTAL LIMITS ON FRUIT FLY DISTRIBUTION AND POPULATION

Native Australian *Bactrocera* fruit flies are generally presumed to have been endemic to coastal tropical and subtropical areas prior to European settlement (Meats 1981). A few species may have had populations attenuating into temperate, coastal south-eastern Australia where suitable native fruits were available. Subsequent rainforest clearing and horticultural expansion is likely to have led to several species, including Queensland fruit fly, extending into fruit production or urban areas throughout south-eastern Australia, largely east of the Great Dividing Range (May 1963, Fletcher 1979, Drew 1989). Not all distributional change is southward. Osborne *et al.* (1997) detail relatively recent range extensions for other *Bactrocera* species from coast to inland areas at similar latitudes, and *vice-versa*.

Population patterns across latitudinal range vary according to climate and resource availability. In the tropical and subtropical coastal areas where many fruit flies evolved, water, food and shelter are abundant, and support large populations that reproduce continuously. Further south and inland, as food becomes patchy and more seasonal, and conditions become cooler or drier, smaller and fewer generations occur.

The effects of increases in latitude, altitude or distance from the sea on fruit fly distribution and population size can be offset by human activity. For example,

Dominiak *et al.* (2006) found that warmer, moister town microclimates enhanced the survival of Queensland fruit fly in dry regions of southern New South Wales. Hence, while summer aridity appears to be a key barrier to fruit fly success in southern Australia, it can be offset to an extent by water and food availability in urban and horticultural production areas. In these circumstances, and although water availability remains important, temperature becomes the main determinant of fruit fly presence and numbers.

Most organisms survive and breed within upper and lower temperature thresholds that can be determined by relatively simple experiments. However, ecological and physiological factors in the field combine to make temperature relations more complex than indicated by laboratory studies. Duration and frequency of high and low temperatures, ability to acclimatise, differing life-stage tolerances and heat requirements come into play. For fruit flies, these complexities influence population parameters at any particular place, including mortality, rate of egg, larval, pupal and adult development, female maturation, mobility necessary for mating, and number of generations possible in a year (Meats 1981). Yonow & Sutherst (1998) and Yonow *et al.* (2004) provide good summaries of Queensland fruit fly biology.

While sustained high temperatures (e.g. 36°C - 40°C for a few days) limit fruit fly survivorship by affecting one or more of these parameters, in southern Australia lower temperatures are comparatively more important, due to regular, prolonged cool periods produced by distinct winter seasons. Since insects require heat from external sources to drive development and enable activity, the winter season can impose significant controls on life-stage and population development.

Accordingly, attempts to explain and predict the survival prospects of dacine flies in southern Australia often use the concept of Day-Degrees. Day-Degrees express heat accumulation over time in a particular place. Day-Degrees can be calculated from daily maximum and minimum temperature records, to approximate the daily heat available to an insect above a threshold temperature below which development does not occur. The accumulated Day-Degrees necessary for life-stage completion is determined by experimentation. The number of Day-Degrees required to complete a life stage and the lower threshold for exploiting heat for development are specific to species and to life stages.

For Queensland fruit fly, the developmental threshold temperatures are 11.5°C (eggs, larvae and pupae) and 13°C (sexual maturation) (Yonow & Sutherst 1998). 315 Day-Degrees above 11.5°C are required for eggs to reach the immature adult stage and another 66 Day-Degrees above 13°C are required for sexual maturation (Anon. 1996a).

For Mediterranean fruit fly, developmental threshold temperatures are lower than for Queensland fruit fly at 9.3°C for eggs, 11.1°C for larvae, 8.4°C for pupae and 12.8°C for sexual maturation (De Lima 2008). 262 Day-Degrees are required for eggs to reach the immature adult stage (combining 44DD above threshold 9.3°C for egg; 162DD above 11.1°C for larva and 56DD above 8.4°C for pupa), while another 36 Day-Degrees above threshold 12.8°C are required for sexual maturation (De Lima 2008). Hence, Mediterranean fruit fly requires less heat to complete a life cycle and can exploit heat from a lower baseline temperature than Queensland fruit fly.

Modelling for fruit flies using Day-Degrees applied to long term daily temperature averages can be used to estimate the time required for life-stage and therefore life cycle completion, likely number of generations, and survival over winter, in any location. Day-Degree models emphasise that the rate of heat accumulation above developmental thresholds is comparatively more important to fruit fly success than how far or how long temperatures drop below these thresholds, assuming lethal temperatures and durations do not occur.

Influences of temperature on parameters for fruit fly success in southern Australia are outlined below. They are illustrated using Queensland fruit fly, the most well studied pest dactylophila fly in Australia with the most southerly distribution.

Temperature and mortality

Of the dactylophila fruit fly life stages, the adult is generally most tolerant of cool temperatures. Egg, larval and pupal stages are unlikely to survive prolonged, seasonal cold of several months but can survive short winters. For example, O'Loughlin (1964) reported that Queensland fruit fly pupae exposed to field temperatures in East Gippsland in February and March emerged as adults after 3 weeks. Pupae exposed in April emerged in June, after 7 weeks. However, pupae exposed in May died and no adults emerged. Near Sydney, Bateman & Sonleitner (1967) buried fresh Queensland fruit fly pupae in experimental plots and observed that adults failed to emerge from batches that were buried later than mid-April. In another study using sheltered field cages in Melbourne, O'Loughlin *et al.* (1984) reported no survival of Queensland fruit fly pupae in the winter months. In comparison, Mediterranean fruit fly is better placed to survive short winters because its threshold for pupal development is significantly lower. Hence, the effective winter period is foreshortened.

Adults of some dactylophila species use acclimation to low temperatures as a strategy to survive short winters. Fletcher (1987) describes this as a facultative reproductive 'diapause' - that is, an 'optional' overwintering mode. Acclimation proceeds with seasonal temperature decline, during which torpor threshold temperatures drop from 7°C in summer to 2°C as winter sets in. If torpor occurs, the flies cannot respond to

their environment and usually die. The effect of cool temperatures on adult fruit fly survivorship has been demonstrated by Bateman (1967), Fletcher (1979), and Meats (2006). O'Loughlin *et al.* (1984) found adults survived for a maximum of 198 days in field cage tests in Melbourne, with mean survival time considerably less. This type of response reflects adaption of Australian dacine pest fruit flies to warm climates with short cool seasons. It is different to the strategy used by truly temperate fruit flies such as *Rhagoletis*. Members of this genus generally have a non-optional, diapausing pupal stage capable of withstanding no growth for long winters, such as occur in North America. *Rhagoletis* also limits its summer generations to ensure synchronisation of the pupal stage with winter.

Overwintering by dacine fruit flies in Australia is generally undertaken by immature adults, with flies that are immature at the start of winter remaining so until conditions warm up. For Queensland fruit fly, individuals that are mature at the onset of the cool season revert to immaturity to overwinter (females resorb eggs in their ovaries). Yonow *et al.* (2004) identified that Queensland fruit fly needs five consecutive days below 18°C for mature female flies to enter an overwintering state and four consecutive days above 18°C for them to leave it.

Temperature and rate of development

The relationship between temperature and rate of life stage development also influences the survival prospects of fruit flies in southern Australia.

Assuming no additional recruitment from outside, the generally poor tolerance of eggs, larvae and pupae to cool conditions means that persistence of fruit flies in any place depends on the time required to reach the adult stage. This affects the number of adults at the onset of winter which in turn influences the number that can survive to reproduce in the following warm season. If the amount of accumulated heat at a place does not allow development of more than one generation per year, the number of adults at the start of winter at that location is likely to be small compared with numbers at localities where more life cycles are possible. Attrition over winter, followed by natural dispersal of immature flies before they mate, further reduces the likelihood of fruit fly persistence in southern Australia.

This trend is demonstrated by the current distribution of Queensland fruit fly. In coastal Queensland, it occurs in high numbers all year, tailing off in the cooler period experienced in the southeast of that state. Up to seven generations per annum are possible. Around Sydney, lower numbers of adults are available to breed in spring but four generations can occur before the next winter. Meats (1981) notes thousand-fold annual fluctuations in coastal New South Wales populations. In irrigated fruit production areas of north eastern Victoria, three to four generations per annum are

possible, giving rise to large permanent populations. In south eastern Victoria, persistent but smaller populations occur, with modelling suggesting around two and a half generations per year (O'Loughlin *et al.* 1984). Further south, populations may become apparent only in summer, or only some summers. These populations are either maintained over time at very low levels or are transient and depend upon recruitment from other areas (Meats 1981).

The developmental rates of lesser pest dacine species have not been studied in detail. These include those that are restricted to north Queensland (*B. frauenfeldi*, *B. kraussi*, *B. melas*, *B. musae*) or Queensland and northern New South Wales (*B. cucumis*, *B. jarvisi*). Of these, only *B. jarvisi* is perhaps extending its Australian range significantly. This is the subject of a current survey in NSW (Gillespie, pers. comm., 2010) and may inform further understanding of its developmental rates.

Gillespie (2003) found the lesser Queensland fruit fly, *B. neohumeralis* as far south as Sydney but trap catches there were erratic and sparse. Meats (2006) found nothing in its temperature responses to explain why it has a more restricted southerly distribution than Queensland fruit fly. Gillespie (2003) also found the northern distribution of lesser Queensland fruit fly is limited. These observations probably confirm that while temperature is fundamental, it is not the only constraint on species' distribution.

Temperature and maturation of females

Female fruit fly sexual maturation is also temperature dependent. Mature females are those whose eggs are developed sufficiently to be fertilised. The threshold for Queensland fruit fly maturation is 13°C, with 66 Day-Degrees required. For Mediterranean fruit fly the threshold for maturation is similar at 12.8°C, but only 36 Day-Degrees are required.

While life stage development times can affect whether adult fruit flies will be around to mate in the warm season and the number of generations per year, female maturation helps determine the earliest time after winter that a new generation can commence. Female maturation defines the start of the period within which egg-laying and egg, larvae and pupal stages must be completed if competent adults are to be available going into the following winter.

Female maturation time therefore puts an additional constraint on establishment prospects. In addition, female maturation time becomes increasingly important where heat accumulation is low because maturation may need to occur twice in a generation that attempts to span winter.

Temperature and activity

Fruit fly success also relies on adults being mobile enough to find each other and mate, visit fruit in order to lay eggs, and disperse after emerging from pupae to find food, shelter and water. Mobility is also temperature dependent. Dominiak *et al.* (2003) note that Queensland fruit fly will not fly below 14°C, and more typically requires temperatures above 16-17°C. Additionally, Yonow & Sutherst (1998) in their fruit fly distribution modelling work adopt 5 consecutive days below 18 °C as the trigger for overwintering behaviour. For fruit flies that mate at dusk, such as Queensland fruit fly, these temperature limits are likely to constrain mating in cool climates in some seasons. Mediterranean fruit fly is less constrained because it mates near midday and has a lower temperature limit for flight activity.

Fruit fly distribution and climate change scenarios

The warming anticipated under climate change scenarios, particularly in inland areas of mainland Australia, is likely to affect the spatial nature of each of the temperature/fly relations described above, and so facilitate changes in fruit fly distribution.

Sutherst *et al.* (2000) modelled the potential distribution of Queensland fruit fly under 0.5°C, 1.0°C and 2.0°C degree increases and made predictions about range expansion, associated impact and implications for management for this species over coming decades. The largest potential impacts above current were predicted within a zone encompassing major fruit production areas in southern New South Wales, northern Victoria, South Australia and south-west Western Australia. Their modelling, *inter alia*, indicates that Day-Degree accumulation above lower threshold temperatures is higher in this zone compared with other areas. These higher temperature scenarios also facilitate more generations per year and reduced winter mortality in areas of southern Australia where Queensland fruit fly currently struggles to persist.

3.1.4 FRUIT FLY DISPERSAL

Fruit fly success in a particular area, as well as being determined by environmental conditions, is also influenced by the ability of flies to get there. Fruit flies generally move from one area to another by flying (adults) or with the assistance of people (all life-stages). Trade in infested produce, especially non-commercial fruit movement is well established as the main pathway along which fruit flies move worldwide between areas and over practically any distance.

Movement by wind or storm activity across water bodies has also been reported, for example by Harris (1977) who noted gravid Mediterranean fruit flies were commonly blown some 20km from Lanai Island to Maui Island, Hawaii. Similar travel across land is not well established (B. Dominiak *pers comm.* June 2011) but may be plausible in certain circumstances. For example, Israeli *et al.* (2005a and 2005b) suggest Mediterranean fruit

fly can move at least 50km in the Negev Desert which is presumably characterised by inhospitable, open terrain. Pupal transport in contaminated substrate or transport of adult hitchhikers on vehicles, are both plausible, although the latter in particular is unlikely to be common.

While there is little argument about human assisted dispersal, fruit fly flight capability and what it means for the prospects of fruit flies accessing uninfested areas is more complex. Several fruit flies are described as strong fliers capable of travelling many kilometres (e.g. Christenson & Foote 1960, Fletcher 1987). For example, Fletcher (1974) established that mature Queensland fruit flies could travel 24km in three weeks. MacFarlane *et al.* (1987) reported a Queensland fruit fly from a sterile fly release program nearly 100km from the release site. Immature adults are generally more dispersive than sexually mature individuals, and movement away from emergence sites, between patches of host trees, or to and from refugia can be in the order of 60km - 100km (Drew *et al.* 1984).

In a review of Queensland fruit fly flight distances, Dominiak (in prep.) contends that although long distance flight can occur, numerous field trapping studies since at least 1949 indicate it is likely to be uncommon compared with more typical flight distances of less than 1km. The field data for dispersal generally fit distributions that drop rapidly and continue with a long 'tail'. Fletcher (1974) proposed an inverse square rule for dispersal from a single point, wherein catch per trap falls away as a reciprocal of the square of distance from the point of release. More recently dispersal of Queensland fruit fly is being considered under other distributions (e.g. Cauchy, inverse power law).

Dominiak (in prep.) argues that flight distances reflect fruit fly responses to resource availability, and are a balance between physiological capacity for dispersal and the distribution, and flowering and fruiting times of host plants in the landscape. That is, if adult and larval food, water and shelter are available in the immediate vicinity, the drivers for fly movement out of an area are weak, meaning most flight will be over short distances. However, if resources are or become limited, long distance flight to seek out more favourable habitat can be triggered, particularly for immature adult flies. Paradoxically, in the context of isolated incursions at least, such dispersal can mean that female Queensland fruit flies will be unlikely to find mates.

These resource-linked behaviours and corresponding patterns in flight distance are observable in other Tephritids. Studies of Mediterranean fruit fly, *Rhagoletis* and *Anastrepha* indicate flight distances of 1km or less are common (Dominiak in prep.). Mediterranean fruit fly appears to be generally less dispersive than Queensland fruit fly. For example, Baker and Chan (1991) found few Mediterranean fruit flies in their trapping experiment moved beyond the 50m trapping array around the release point.

3.2 PEST CATEGORISATION

Fourteen fruit fly species identified from the National Fruit Fly Strategy (PHA 2008) and/or White & Elson-Harris (1992) as being present and having economic or potential economic significance in mainland Australia were categorised.

Presence on mainland Australia was determined primarily from Drew (1989), Hancock *et al.* (2000) and the Australian Plant Pest Database (APPD). Several species of fruit fly are not attracted to common chemical lures which means these may go undetected in some circumstances. However, the species distributions reported in Drew (1989), Hancock *et al.* (2000) and APPD incorporate presence/absence information from a variety of entomological observations. Other research over time, and direct discussion with mainland fruit fly specialists did not reveal anything to the contrary. Therefore, it was assumed non-responsiveness to chemical lures does not significantly undermine confidence in distributions reported in those publications.

Potential association with fruit was considered plausible if the fruit fly species had been recorded on commercial produce that is also known to be imported to Tasmania.

Potential for establishment in Tasmania was evaluated taking into account current distribution reported primarily from Drew (1989), Hancock *et al.* (2000) and the APPD, and the presence of known hosts in Tasmania. If there was no evidence of distribution in Victoria or south western Western Australia, or upland areas further north, and/or hosts are not grown in Tasmania, establishment was assumed to be implausible. Occasional cultivation of tropical or subtropical host plants in Tasmanian home gardens was assumed to be insignificant in the establishment prospects of fruit flies.

Potential for impact in Tasmania was evaluated taking into account the range of potentially affected hosts in Tasmania in commercial or non-commercial situations, and quarantine status on the mainland Australia and overseas.

Categorisation results in Table 6 show Queensland fruit fly and Mediterranean fruit fly are candidates for further assessment. Both are present in southern Australia and have large host ranges that include species grown in Tasmania. Another two species were included in the concept of Queensland fruit fly due to overlapping taxonomies. The remaining ten species were excluded from further assessment either because the pathway association appears very weak or establishment in Tasmania at this time is unlikely, given host range and/or climatic preference.

Table 6 - Fruit fly categorisation

Pest	Presence Mainland Australia	Presence Tasmania	Regulatory status Tasmania	Potential association with fruit	Potential for establishment	Potential for consequence	Quarantine Pest?	Comments
<i>Bactrocera aquilonis</i> Northern Territory Fruit Fly	NT and WA	Absent	None	Plausible	Plausible	Plausible	Yes	Present in the Northern Territory and northern Western Australia. A regulated pest in five overseas countries (AQIS 2009). Regarded here as conspecific with <i>B. tryoni</i> for the reasons outlined in Clarke <i>et al.</i> (2010).
<i>Bactrocera bryoniae</i>	WA, NT, QLD, NSW	Absent	None	Implausible	Not assessed	Not assessed	No	Present in northern Western Australia, the Northern Territory, Torres Strait Islands, Queensland and New South Wales as far south as Sydney (Hancock <i>et al.</i> 2000). Infests wild species of Cucurbitaceae and <i>Passiflora</i> (Hancock <i>et al.</i> 2000). Records from capsicum thought to be erroneous. Not considered further due to lack of commercial hosts imported into Tasmania.
<i>Bactrocera cucumis</i> Cucumber Fruit Fly	QLD, NT, northern NSW	Absent	None	Has occurred and remains plausible	Implausible	Not assessed	No	Present in the NT, along the Queensland coast and in northern NSW (Drew 1989). Described as ‘essentially a tropical species’ (HPC 1991). Infrequent in northern NSW (P. Gillespie pers. comm., 2010) Hosts include Solanaceae (e.g. capsicum, chilli, tomato), Rutaceae (e.g. orange, lemon, grapefruit, mandarin) and Cucurbitaceae (e.g. watermelon, cucumber, pumpkin, squash and zucchini), snake gourd, guava bean (CABI 2007, Corcoran <i>et al.</i> 1993, Hancock <i>et al.</i> 2000). Detected twice in pumpkin from the mainland to Tasmania over the last 10 years. Not considered further due to unlikely survival in Tasmania, based on mainland distribution.
<i>Bactrocera expandens</i>	North-eastern Australia	Absent	None	Implausible	Not assessed	Not assessed	No	Recorded from egg tree (<i>G. zanthochymus</i>) and mundur (<i>G. dulcis</i>) (Hancock <i>et al.</i> 2000). Not considered further due to absence of known commercial hosts imported into Tasmania.
<i>Bactrocera frauenfeldi</i> Mango Fruit Fly	QLD	Absent	None	Plausible	Implausible	Not assessed	No	Present in the Torres Strait Islands and northeast Queensland to Townsville (Hancock <i>et al.</i> 2000). Introduced from Papua New Guinea over 30 years ago (Smith 2000). It does not occur in the Northern Territory (Chin, pers comm., 2010). Host range includes fruit commonly imported into Tasmania - mango, pawpaw, banana, guava and citrus (Hancock <i>et al.</i> 2000). Not considered further due to unlikely survival in Tasmania based on mainland distribution.

Pest	Presence Mainland Australia	Presence Tasmania	Regulatory status Tasmania	Potential association with fruit	Potential for establishment	Potential for consequence	Quarantine Pest?	Comments
<i>Bactrocera halfordiae</i>	Eastern Australia (NSW)	Absent	None	Plausible	Implausible	Not assessed	No	Recorded on citrus, loquat and feijoa in 1953 (May 1953). More recent reports suggest it is an incidental pest of citrus and attacks loquat and some myrtaceous fruits (NSWAg 1998). Listed as a quarantine pest by Thailand for citrus. Present coastal northern NSW. Not considered further due to unlikely survival in Tasmania based on mainland distribution.
<i>Bactrocera jarvisi</i> Jarvis' Fruit Fly	NT, QLD, NSW, WA	Absent	None	Has occurred and remains plausible	Implausible	Not assessed	No	Polyphagous. Major hosts are <i>Mangifera indica</i> (mango), <i>Psidium guajava</i> (guava) and <i>Terminalia catappa</i> (Pacific almond, Singapore almond) (CABI 2007, Hancock <i>et al.</i> 2000) Present in the Northern Territory, Queensland, New South Wales and Western Australia (Drew 1982, Hancock <i>et al.</i> 2000). A survey using a newly developed lure is being conducted in New South Wales to clarify the distribution of this pest (Gillespie, pers. comm., 2010) Intercepted in Tasmania in mango fruit from the NT in 2007. Regulated by USA, New Zealand, India, Jordon, Pakistan, Sri Lanka and Thailand (AQIS 2009). Not considered further due to unlikely survival in Tasmania based on mainland distribution.
<i>Bactrocera kraussi</i> Krauss's Fruit Fly	QLD	Absent	None	Plausible	Implausible	Not assessed	No	Present in the Torres Strait Islands and northeast Queensland to Townsville (Hancock <i>et al.</i> 2000). APPD records are mostly from far north Queensland with a few as far south as Mackay. Reported on mango, banana, feijoa, apple, peach, passionfruit, citrus, chilli and tomato (Hancock <i>et al.</i> 2000). Not considered further due to unlikely survival in Tasmania based on mainland distribution.
<i>Bactrocera melas</i>	QLD	Absent	None	Plausible	Plausible	Plausible	Yes	Present in eastern Queensland, particularly in the southeast (Hancock <i>et al.</i> 2000). Regarded here as conspecific with <i>B. tryoni</i> for the reasons outlined in Clarke <i>et al.</i> (2010).
<i>Bactrocera musae</i> Banana Fruit Fly	QLD	Absent	None	Plausible	Implausible	Not assessed	No	Present in Queensland. Host range is papaw, banana, wild banana, plantain and guava. Regarded as an exclusively tropical species (HPC 1991). Not considered further due to unlikely survival in Tasmania based on mainland distribution and absence of hosts in Tasmania.
<i>Bactrocera mutabilis</i>	QLD	Absent	None	Plausible	Implausible	Not assessed	No	Present in Eastern Queensland (Hancock <i>et al.</i> 2000). Recorded from round kumquat (<i>Fortunella japonica</i>) and one specimen of guava (<i>Psidium guajava</i>) (Hancock <i>et al.</i> 2000). Not considered further due to limited known commercial hosts imported into Tasmania and unlikely survival in Tasmania based on mainland distribution.

Pest	Presence Mainland Australia	Presence Tasmania	Regulatory status Tasmania	Potential association with fruit	Potential for establishment	Potential for consequence	Quarantine Pest?	Comments
<i>Bactrocera neohumeralis</i> (Hardy)	QLD, NSW, NT	Absent	None	Plausible	Implausible	Not assessed	No	Polyphagous. Major host is guava (<i>Psidium guajava</i>) (CABI 2007). Typically a coastal species from Queensland and northern New South Wales (Osborne <i>et al.</i> 1997). Trapping over three decades indicates it regularly occurs as far south as Coffs Harbour and sporadically as far south as Sydney (Gillespie, pers. comm., 2010). Detected in the Northern Territory in 2004. Regulated by USA, New Zealand, India, Jordan, Pakistan, Sri Lanka and Thailand (AQIS 2009c). Not considered further due to unlikely survival in Tasmania based on mainland distribution. Additionally <i>B. neohumeralis</i> not considered conspecific to <i>B. tryoni</i> . See Clarke <i>et al.</i> 2010 for a recent summary of the scientific debate about the <i>B. tryoni</i> species complex as defined by Drew (1989).
<i>Bactrocera tryoni</i> Queensland Fruit Fly	QLD, NSW, VIC, NT	Absent	List A ⁴	Has occurred and remains plausible	Plausible	Plausible	Yes	Polyphagous. Endemic in eastern Queensland, eastern NSW and eastern Victoria. Present in southern Victoria and the Northern Territory. Outbreaks occur periodically in South Australia and to a lesser extent, Western Australia. Intercepted in Tasmania in fruit on 12 occasions since 2007. A quarantine pest for many countries.
<i>Ceratitis capitata</i> Mediterranean Fruit Fly	WA	Absent	List A	Plausible	Has occurred temporarily, remains plausible	Plausible	Yes	Polyphagous. Introduced into Western Australia, where it is distributed in the south-west to Broome in the north (Hancock <i>et al.</i> 2000). Introduced into New South Wales, Queensland, Tasmania and Victoria in the early 1900s but these populations disappeared. Periodic outbreaks in northwest Western Australia, South Australia and the Northern Territory. A quarantine pest for many countries.

⁴ List A is a term in the *Plant Quarantine Act 1997* that means a pest of quarantine concern that is not present in Tasmania

3.3 PEST RISK ASSESSMENT FOR QUEENSLAND FRUIT FLY

3.3.1 PEST PROFILE

CURRENT VALID NAME

Bactrocera (Bactrocera) tryoni (Froggatt)

SYNONYMS

Dacus tryoni (Froggatt)

Chaetodacus tryoni (Froggatt)

Strumeta tryoni (Froggatt)

Dacus ferrugineus tryoni (Froggatt)

Tephritis tryoni Froggatt

Note: For this review *B. aquilonis* and *B. melas* are included in assessments and regulations dealing with *B. tryoni*.

ORIGIN

Native to Australia. Queensland fruit fly has been detected but is no longer present in California, New Zealand, Papua New Guinea and Chile. It has a restricted distribution in New Caledonia and French Polynesia (CABI 2007).

AUSTRALIAN DISTRIBUTION

Queensland fruit fly occurs along the eastern seaboard from Cape York Peninsula to Melbourne (Osborne *et al.* 1997). It is endemic in eastern Queensland, eastern NSW and eastern Victoria. It has been reported as far west as Mount Isa, Queensland (Hancock *et al.* 2000). Queensland fruit fly is not established in South Australia or Western Australia, although outbreaks occur periodically. Similarly, certain production areas in Victoria, New South Wales and the Northern Territory are free of Queensland fruit fly, but experience outbreaks. Queensland fruit fly is absent from Tasmania. The first detections in Tasmanian traps occurred in February 2011 but establishment did not occur.

HOSTS⁵

Acca sellowiana (Feijoa); *Actinidia deliciosa* (Kiwifruit); *Annona* spp.; *Capsicum annuum* (Capsicum and Chilli); *Carica papaya* (Papaya, Paw Paw); *Citrus* spp. (including grapefruit, lemon, mandarin, orange); *Cydonia oblonga* (Quince); *Cyphomandra betacea* (Tamarillo, Tree tomato); *Eriobotrya japonica* (Loquat); *Ficus carica* (Fig); *Fortunella* spp. (Kumquat); *Fragaria x ananassa* (Strawberry); *Litchi chinensis* (Lychee); *Lycopersicon lycopersicum* (tomato); *Malus domestica* (Apple); *Mangifera indica* (Mango); *Morus nigra* (Mulberry); *Musa* spp. (banana); *Passiflora* spp. (including various Passionfruit); *Persea americana* (Avocado); *Phoenix dactylifera* (Date palm); *Prunus* spp. (including Apricot, Cherry, Nectarine, Peach and Plum);

⁵ List comprises most common hosts only and should not be read as a full host list

Psidium spp. (including various Guava); *Punica granatum* (Pomegranate); *Pyrus communis* (Pear); *Pyrus pyrifolia* (Nashi); *Rubus* spp. (including Blackberry, Raspberry, Loganberry, Youngberry); *Solanum melongena* (Eggplant); *Solanum muricatum* (Pepino); *Vaccinium corymbosum*, (Blueberry); *Vitis vinifera* (Grape).

Sources: CABI 2007, White & Hancock 1997, Hancock *et al.* 2000, CoP 1996.

3.3.2 LIKELIHOOD OF ENTRY, ESTABLISHMENT AND SPREAD

LIKELIHOOD OF ENTRY

Importation: Queensland fruit fly is polyphagous and attacks many types of commercially traded fruit in Australia. Tasmania imports around 25 000 tonnes of various host fruit from the Australian mainland each year, most of which is derived from eastern Australian production regions where Queensland fruit fly is either endemic, or fruit fly free but subject to outbreaks.

Quality management in commercial fruit production can be expected to ameliorate but not eliminate the chance of Queensland fruit fly larvae in imported commercial produce. Routine crop and orchard monitoring, and in-line grading, sorting and inspection is likely to result in removal of most fruit showing signs of infestation. However, Queensland fruit fly oviposition sites (stings) are not always visible and infected fruit can show no outward signs. Hence, infestation may not be detected, either during consignment preparation or on-arrival inspection.

Transit times are generally short, meaning fruit can be available to consumers anywhere in Australia days after harvest. Short time from harvest to consumer also reduces the likelihood of infestation being detected, especially in late-stung fruit. Cool storage during transit may slow egg and larval development but is unlikely to be applied long enough to cause mortality.

The DPIPWEE holds records for Queensland fruit fly pertaining largely to barrier interceptions of infested fruit, or infested, imported fruit reported by the public. Seven detections of larvae in imported commercial fruit have occurred since early 2007. In February 2011, in a season characterised by a high number of Queensland fruit fly outbreaks in south eastern Australia, two male Queensland fruit flies were detected in traps in Hobart within 1 km of each other within a week. This represented the first detections of Queensland fruit fly in the State trapping grid. The DPIPWEE was unable to verify the source of the larvae that gave rise to these flies, and whether it was commercial or non-commercial imported fruit.

Distribution: Imported host fruit is sold and distributed for consumption at multiple locations across Tasmania. Infested fruit could be discarded to compost heaps, roadsides, or

landfill where larvae could emerge and pupate. Emerging adults have sufficient dispersal ability to reach food, shelter and water, none of which are limiting in Tasmania.

Taking into account importation and distribution factors, the likelihood of entry of Queensland fruit fly in commercially produced mainland host fruit is estimated at **MODERATE**.

LIKELIHOOD OF ESTABLISHMENT

Establishment occurs if imported larvae give rise to self-sustaining populations of flies able to successfully overwinter and resume activity in the following spring-summer. Transient occurrence occurs if imported larvae give rise to adult populations before winter. However, those adults and any offspring do not survive beyond winter.

To investigate potential for Queensland fruit fly to occur transiently or become established in Tasmania, the fate of fully grown larval cohorts hypothetically imported into Launceston in fruit each month of the year, was modelled by calculating heat summation according to:

$$\text{Day-Degrees} = ((T_{\text{max}} \text{ } ^\circ\text{C} + T_{\text{min}} \text{ } ^\circ\text{C}) / 2) - \text{developmental threshold } T \text{ } ^\circ\text{C}$$

This simple Day-Degree formula was chosen because it reflects the widely agreed proposition that temperature is the main determinant of Queensland fruit fly establishment potential in south eastern Australia, and is also used in the CoPs.

The formula, combined with three additional constraints described below, was selected in preference to other, more sophisticated modelling options (e.g. CLIMEX (as per Yonow & Sutherst 1998), DYMEX™ (Maywald *et al.* 1999)) primarily to allow scenarios of seasonal transient occurrence to be investigated easily and to directly investigate the impacts of two rounds of female maturation that need to occur and which are not accounted for in the CLIMEX model. As noted below, the CLIMEX model has already shown Tasmania unsuitable for permanent establishment. In the future, DYMEX may be adopted for modelling transient scenarios although there remains uncertainty in setting parameters for modelling at suboptimal temperatures in the range 2-12°C.

In applying the Day-Degree formula, Launceston was chosen because it is among the warmer sites in Tasmania, with more heat available for Queensland fruit fly development between late spring and early autumn. Hobart is the next most climatically favourable site, and Grove in the south is the least favourable (Figure 1).

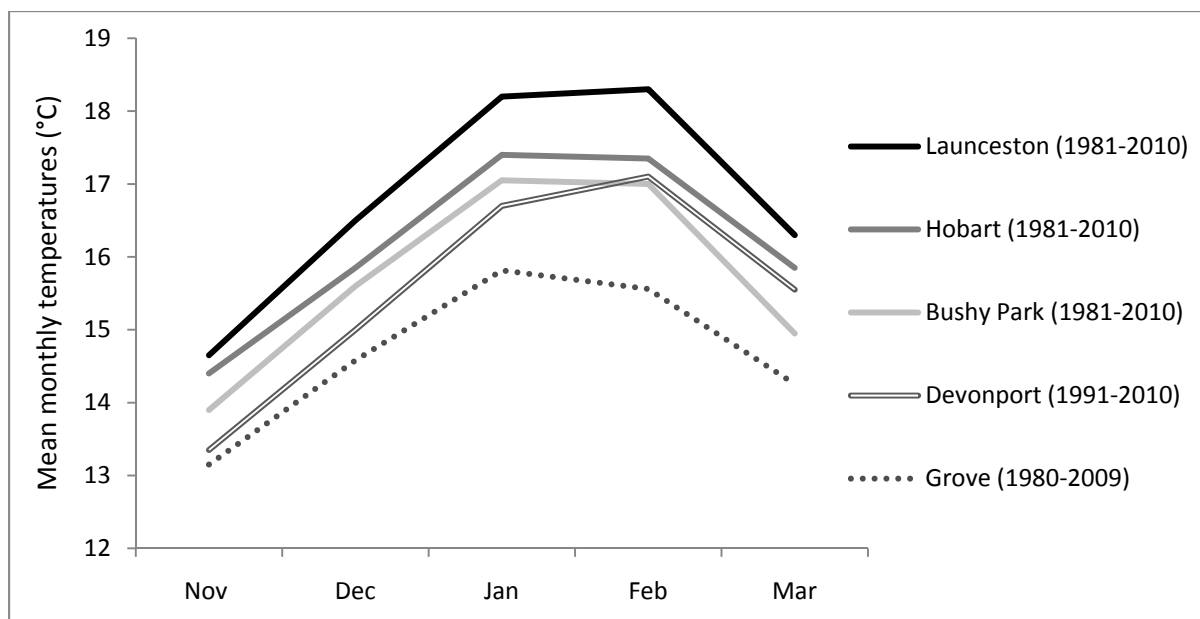


Figure 1 - Mean monthly temperatures (Nov-Mar) at five urban or horticultural Tasmanian sites

The modelling assumes that adult flies attempting to overwinter in Tasmania would need to resorb eggs going into winter and develop mature eggs again in the following season. The 198 day maximum length of adult Queensland fruit fly survival found by O’Loughlin *et al.* (1984) is also used to limit overwintering by adults. Eggs, larvae and pupae are assumed to perish when no growth occurs for several weeks. That is, the modelling also takes into account periods when development is unlikely, and the likely impact of these cool periods on various life stages not adapted to sustained dormancy.

It is also assumed there are no other impediments to life cycle completion apart from temperature – i.e. larvae remain viable in imported fruit, the fruit is discarded to a site that is otherwise suitable for pupation, emergent adults find shade, food and water to attain maturity and mate, and mated females find host fruit in which to deposit eggs.

The modelling results (Figure 2) suggest the following six scenarios for mature larvae hypothetically imported into Launceston.

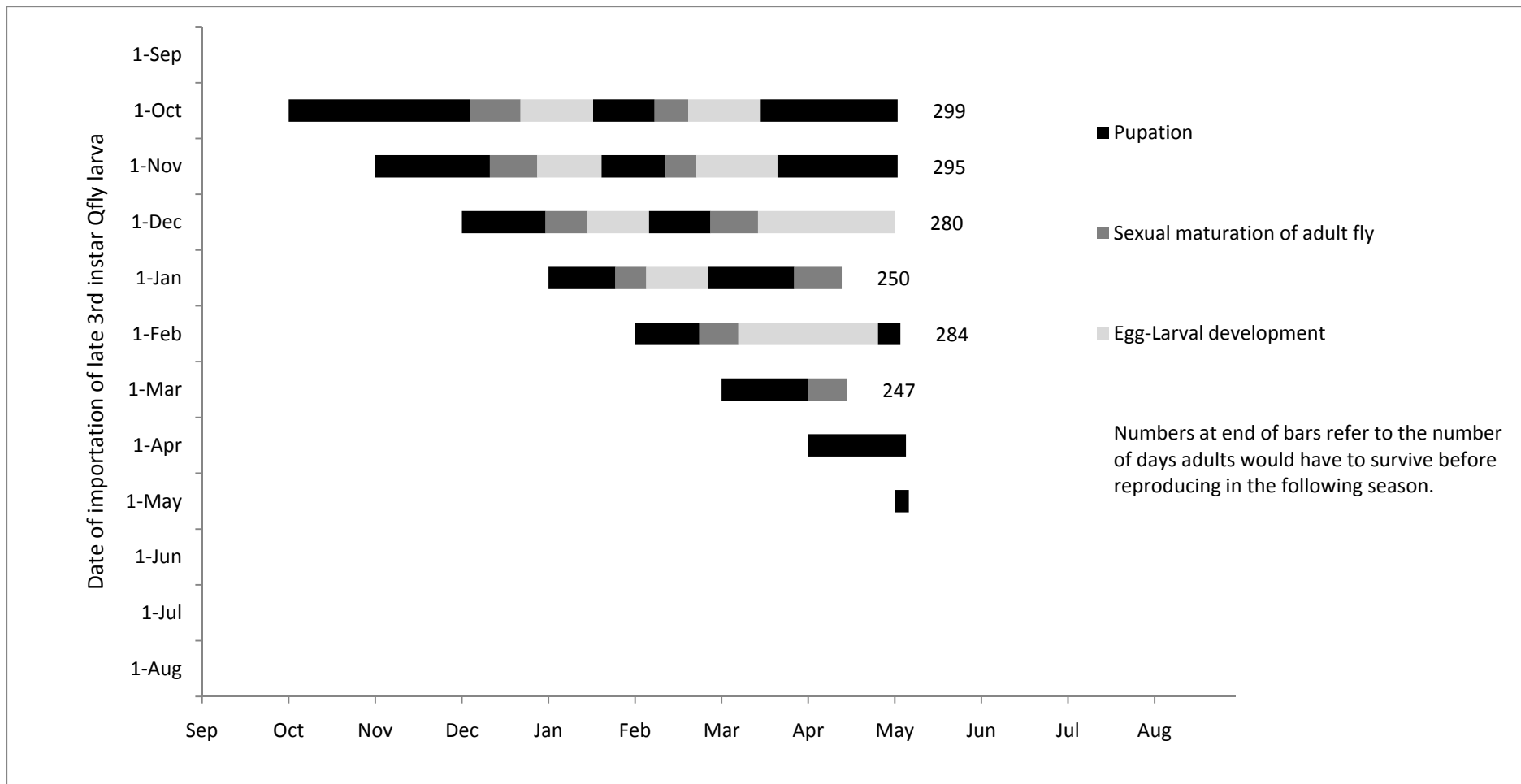


Figure 2 - Predicted life cycles and stages arising from fully grown larval cohorts of Queensland fruit fly imported into Launceston in fruit at the start of each month

Scenario 1: Larvae imported in fruit between **April and September** would probably experience 1-5 months of temperatures at which no or very little growth is likely. These larvae are therefore unlikely to develop into adult flies. Queensland fruit fly larvae and pupae are not adapted to remain dormant for long periods. Hence, larvae entering in April, May, June, July, August and September are likely to perish from cold soon after, or if they pupate, soon after that.

Scenario 2: Larvae imported in **October and November** would have an increasing chance of successfully pupating and emerging as immature adult flies. All cohorts of immature adults arising from larvae imported in October or November would not be expected to emerge until early to mid-December. By the end of December all cohorts would probably have received enough heat to become sexually mature. Eggs laid by these adults could give rise to a local generation of immature flies in early to mid-February. These flies could mature enough to seek mates and lay eggs in late February.

Larvae developing from these eggs would probably perish either as larvae or as pupae over March-April. Likely exposure to prolonged cool conditions would probably prevent them from further development.

Actively reproducing flies typically live 2-3 months in warm parts of Australia, but during April in Launceston, survivors of the cohort that laid eggs in late February are likely to enter a sedentary overwintering state, triggered by consecutive maximum temperatures below 18°C. Females are likely to resorb eggs in their ovaries. Given the 198 day maximum found by O'Loughlin *et al.* (1994), it is unlikely that these adult flies could survive 290 days from emergence to early December when a second round of sexual maturation could be completed.

Scenario 3: Larvae imported at the start of **December** would probably develop into flies by the end of that month, before maturing enough to seek mates and lay eggs from mid-January onwards. These eggs could give rise in late February to a local generation of immature flies. These flies could reach sexual maturity, mate and lay eggs from mid-March. Larvae arising from these eggs would probably be unable to reach the pupal stage and are likely to perish over winter. Surviving adults would enter an overwintering stage during April, and would be unlikely to survive the 280 days from emergence to a second round of sexual maturation in the following season.

Scenario 4: Larvae imported at the start of **January** would probably develop into immature flies by the end of that month, before maturing enough to seek mates and lay eggs from early-February. These eggs could give rise in late March to a local

generation of immature flies. However, these adults would probably not be able to reach maturity. They would be forced to enter an overwintering stage during April. It is unlikely that these adults would survive the 250 days from emergence to sexual maturity in the following season.

Scenario 5: Larvae imported at the start of **February** would probably develop into immature flies by the end of that month, before maturing enough to seek mates and lay eggs from early-March. Larvae hatching from these eggs would probably perish over winter, either as larvae or pupae. A local generation of adults is unlikely. Any surviving adults would probably enter an overwintering stage during April, and would be unlikely to survive 280 days from emergence to sexual maturity in the following season.

Scenario 6: Larvae imported at the start of **March** would probably develop into immature flies by early April. These adults are unlikely to reach sexual maturity and would probably be forced to enter an overwintering stage during April. It is unlikely that these adults would survive 240 days from emergence to sexual maturity in the following season.

Discussion: The modelling suggests that Launceston could support one complete local generation⁶ of Queensland fruit fly per year, over summer to early autumn. Hence, active flies appear possible between December and early April. However, individuals in any life-stage are unlikely to persist over the subsequent winter and initiate the next cohort, meaning the single local generation is likely to be transient. The shortest overwintering period is likely to be experienced by adults emerging from larvae introduced into Launceston (or Hobart) in mid-March. These flies would need to survive for 210 days before being able to reproduce in the following warm season. This exceeds the known experimental limit of around 198 days (O'Loughlin *et al.* 1994), and suggests survival is unlikely. It also greatly exceeds a 135-day overwintering period calculated for Melbourne using the same method and temperature averages for the last 30 years.

It follows that parts of Tasmania characterised by less heat in the warm season than Launceston or Hobart, such as the Huon Valley, Derwent Valley and North-west Coast, are less likely to support a local generation. In addition, most adult flies arising from a local generation at Tasmanian sites outside Launceston or Hobart would need to survive for 240-300 days before being able to reproduce in the following warm season. This is also unlikely.

⁶ Wherein a local generation starts with eggs and ends with the next cohort of eggs laid

The modelling results agree broadly with those of Meats (1981), who also chose Launceston as the site in Tasmania where Queensland fruit fly might have the best prospects, and recognised the constraint on establishment that occurs when only one generation is feasible between overwintering events. The analysis is also broadly consistent with CLIMEX-based investigations for Australia, including Tasmania (Yonow & Sutherst 1998) and more recently for Tasmania from the present until 2085, using a fine 0.1 degree climate data grid (Potter & Kriticos in prep.). Both suggested Tasmania is currently unsuitable for permanent establishment for Queensland fruit fly but that Launceston and Hobart could support transient occurrence.

In addition, Yonow & Sutherst (1998), who adopted the 380 'Sunraysia' Day-Degree setting for single generation time, noted that their results would more closely resemble those of Meats (1981) had they used 450 Day-Degrees. The difference of 70 Day-Degrees is close to the time a female requires to mature her eggs (66 Day-Degrees), meaning that 450 Days Degrees allows for the known adult overwintering strategy involving reabsorption of eggs at winter onset and maturation of new eggs in spring.

Establishment prospects under warmer conditions? To test the effect of warmer conditions in Launceston all year round, daily minima and maxima were increased by one degree Celsius. Under this scenario, two local generations of Queensland fruit fly are possible if larvae were introduced in infested fruit in October or November. Larvae introduced from December onwards are unlikely to lead to a second local generation. Adult flies arising from a second local generation would still need to survive for 230-250 days before being able to reproduce in the following warm season. This is unlikely.

The shortest possible overwintering period under this higher temperature scenario is experienced by adults emerging from larvae introduced into Launceston or Hobart in late-March. These flies would need to survive for around 180 days before being able to reproduce in the following warm season, which is possible given O'Loughlin *et al.*'s (1984) maximum of 198 days, but still unlikely. Dominiak (*pers comm.* 2011) observed survival of sterile Queensland fruit fly for a similar duration including the cool season near Griffith, New South Wales.

To consider how much warmer it would need to become for Queensland fruit fly to overwinter and hence establish in Tasmania, a comparison was made between temperatures in Launceston and Hobart, and Melbourne over the last 30 years and in 2008 when Queensland fruit fly is reported to have overwintered there successfully (Table 7). The comparison indicates Launceston and Hobart would need

to experience an increase in excess of 3°C through the year to emulate Melbourne temperatures, and hence support overwintering of Queensland fruit fly.

Table 7 - Minimum age of adult Queensland fruit fly from emergence in autumn to egg-laying in spring

Site	Temp data set	Minimum fly age
Launceston	last 30 year average	213
Launceston	last 30 year average + 1°C	188
Launceston	last 30 year average + 2°C	160
Launceston	last 30 year average + 3°C	135
Hobart	last 30 year average	210
Hobart	last 30 year average + 1°C	176
Hobart	last 30 year average + 2°C	154
Hobart	last 30 year average + 3°C	122
Grove	last 30 year average	256
Orbost	last 30 year average	164
Echuca	last 30 year average	167
Melbourne	last 30 year average	135
Melbourne	2008	90

Summary: Transient occurrence of Queensland fruit fly in Tasmania appears possible in parts of Tasmania under current climatic conditions. Permanent establishment is unlikely, but could be expected in the future should temperature increases in the order of 3°C occur.

Given the above, the likelihood of Queensland fruit fly establishing in Tasmania is estimated at **LOW**.

LIKELIHOOD OF SPREAD

The main mechanisms by which Queensland fruit fly could move within Tasmania are natural adult dispersal or transport of larvae in infested fruit by people. Movement by wind or adult hitchhiking on vehicles is possible but less likely, and less likely to lead to spread of propagules sufficient in number to found a new population.

Natural dispersal is likely to be limited below maximum daily temperatures of 18°C but in urban areas host trees are unlikely to be limiting and flies would probably need to travel less than 1-2km to find them. Human-assisted movement is not constrained and larvae or adult flies could be transported quickly and in a viable state to any part of Tasmania.

However, the same temperature parameters that influence development from the imported larval cohort would also influence and generally limit the prospects of subsequent development from the first local generation at additional places, many of which will be less suitable.

The likelihood of Queensland fruit fly spreading in Tasmania is therefore estimated at **LOW**.

LIKELIHOOD OF ENTRY, ESTABLISHMENT AND SPREAD L(EES) LARVAE:

Using the combination rules described in Part Two the likelihood of Queensland fruit fly entering, establishing and spreading in Tasmania in the absence of phytosanitary measures is:

MODERATE X LOW X LOW = VERY LOW L(EES)

3.3.3 MAGNITUDE OF CONSEQUENCES

Direct Consequences:

If Queensland fruit fly were to enter, establish and spread in Tasmania in the way outlined in the previous section, two types of direct consequence are possible.

Impact on plant life and health:

There are approximately 5000 hectares of commercial fruit plantings in Tasmania (ABS 2007/08) comprised of species known to be susceptible to Queensland fruit fly (e.g. pomes, stonefruit, grapes, berries). The same and additional host species are common in home gardens, and to a lesser extent, amenity plantings. Roadside *Malus* and *Prunus* and weedy *Rubus fruticosus* are also common. Therefore, potential impacts on plant life or health are not limited by host availability.

Commercial fruit production occurs state-wide but is concentrated in four regions – Greater Hobart, Southern, Northern and Mersey-Lyell, with Greater Hobart and the Southern regions accounting for 60% of production (ABS 2007/08). In addition, Tasmania's population is highly decentralised (DPIPWE 2010) so fruit fly populations initiated from infested imported fruit distributed to urban areas or small towns could be in the vicinity of, and move or be moved to, commercial fruit orchards.

However, temperature modelling indicates Queensland fruit fly is unlikely to establish permanent or large populations in Tasmania due to insufficient heat accumulation for life-stage completion, even at more favourable sites. Hence, damage to host fruit is likely to be discernible but substantially less than that experienced on the Australian mainland.

Small populations of actively flying, mature flies capable of laying eggs are possible between January and early April in warmer areas. Consequently fruit damage could occur during this period. Immature flies may also be present during December and into early April, but these do not sting fruit and their feeding habits are unlikely to damage plants. Populations are not anticipated to survive winter in Tasmania, and hence direct impacts could be considered reversible, even in the absence of eradication efforts. However, assuming infested fruit continues to be imported, repeat occurrences in subsequent years could occur.

Prospects for transient populations are less favourable in cooler areas of Tasmania, including production areas in the State's south.

Thus, direct impacts of Queensland fruit fly on host plants in Tasmania are likely to be *minor* at the regional level and *indiscernible* at the State level. **Impact score = D**

Impact on any other aspects of the environment

Introduced species may exert direct impacts on soil and water microfauna, other biota, or water quality and other dimensions of the physical environment. However, unless these impacts are obvious, they are likely to go unnoticed and escape investigation. This appears to be the case for Queensland fruit fly, known primarily for its impacts on fruit.

Larval damage to fruit of Tasmanian native plants, including *Rubus* and a large number of fruiting plants in the Family Myrtaceae, is plausible. Absence of reports on native plants other than tropical or sub-tropical species on mainland Australia suggest this is unlikely to occur at high levels or otherwise affect Tasmanian native plant health.

In Tasmania, direct effects of Queensland fruit fly on the environment, other than on host plants, and given limited establishment potential, are likely to be *indiscernible* at regional and State levels. **Impact score = C**

Indirect Consequences

Taking into account the types of direct consequence that could occur if Queensland fruit fly were to enter, establish and spread in Tasmania, four types of potential indirect impacts are possible.

Costs of eradication and control

Under current Tasmanian conditions, Queensland fruit fly populations are likely to perish over winter without human intervention. Nonetheless, if they were detected either in the trapping network or in local fruit, activity aimed at incursion delimitation and eradication would ensue immediately, hence incurring costs.

Costs of Queensland fruit fly and Mediterranean fruit fly eradication on the Australian mainland are summarised in Table 8. Costs appear to be in the order of \$100 000 - \$200 000 per outbreak. Queensland fruit fly outbreaks are defined under the COP as occurring when any of the following 'triggers' occurs:

- one larva is detected in local fruit; or
- a gravid female is detected; or
- three male flies are detected in a trap or traps within 1km of each other within 14 days, in the absence of supplementary trapping⁷; or
- five male flies are detected within 1km of each other within 14 days where supplementary trapping has been deployed.

⁷ Proposed for the revised Fruit Fly Code of Practice

The figures in Table 8 are likely to reflect proficiencies and efficiencies accumulated in government, industry and the community from years of experience in responding to fruit fly outbreaks.

Table 8 - Cost of eradicating fruit flies- some mainland examples

Year	Species	Location	Cost of operation	Reference
1989 - 1991	Queensland fruit fly	Perth	\$8.5 million	300km ² Baiting, SIT and Cue lure (Fisher 1996)
1995	Queensland fruit fly	Victoria Park	\$250 000	4 flies only in less than 25km ²
2003 - 2008	Queensland fruit fly	NSW (FFEZ)	\$10 million	Cost of control program for several outbreaks was \$10,000,000 (OCPPO 2007). Cost per eradication is \$135000 - \$200,000 assuming 15 to 20 outbreaks over the five years (based on the 16 outbreaks in 2008/09).
2003 - 2008	Queensland fruit fly	Vic (FFEZ)	~\$7.3 million	Cost of control program for several outbreaks was \$7,260,000 (OCPPO 2007). Kalang (2008) report that the cost increased from \$2million in 2000 to \$7 million in 2008/09 due to an increase in the number of outbreaks per annum. Each outbreak cost an estimated \$200,000 based on 37 outbreaks for 2008/09.
2003 - 2008	Queensland fruit fly & Mediterranean Fruit Fly	SA (FFEZ)	~\$2.1 million	Cost of control program for several outbreaks was \$2,059,000 (OCPPO 2007). The cost per outbreak is \$103,000-\$206,000 based on 2-4 outbreaks per year (Maelzer <i>et al.</i> 2004) but may include roadblock costs at \$1million per year.

In Tasmania's case, detection of fruit fly, even below outbreak levels defined in the CoP, would elicit State biosecurity emergency response arrangements, coordinated from a State Control Centre and informed by the State contingency plan for fruit fly incursions (DPIPWE in draft). While Tasmania has response coordination capacity for any type of pest outbreak, interstate expertise would be sought to help ensure on-ground operations for Queensland fruit fly were effective and efficient.

Indeed, in February 2011, when two Queensland fruit flies were detected in Tasmania's trapping network for the first time, a variety of activity ensued despite the fact that an outbreak under the CoP definition had not occurred. Supplementary traps were immediately deployed and monitored for nine weeks, backyard fruit in

the supplementary trapping area was collected, cut and inspected, households were doorknocked to increase awareness, chemical was purchased, expert interstate advice was sought and a DPIPWE emergency response team was put on standby.

Hence, eradication costs for Queensland fruit fly are likely to be of a similar magnitude to those incurred on the mainland, somewhat higher for the first outbreak, and reducing as local expertise develops.

The magnitude of impact associated with costs of eradication and control of Queensland fruit fly in Tasmania is likely to be *minor* at the State level. **Impact score = E**

Effects on domestic and international trade

The Tasmanian Food and Beverage Industry Scorecard for 2007/08 estimated the packed and processed value of fruit at \$94.6 million. This comprised fruit exports to overseas and interstate markets, worth \$11 million and \$44 million respectively. For that period, Tasmanian businesses, supported by demand associated with tourism, bought approximately \$39 million worth of fruit, which contributed to \$151⁸ million in retail and food services sale. Given the profile of Queensland fruit fly as a quarantine and production pest, there is little doubt that State freedom plays a role in facilitating these returns and strengthening prospects for local industry export expansion.

Detection of Queensland fruit fly in Tasmania has potential to affect both domestic and international trade. The likely magnitude of this is governed to an extent by outbreak triggers in the Queensland Fruit Fly Code of Practice. The outbreak triggers are accepted by all mainland jurisdictions and, with some variations, by most major international trading partners. If an outbreak trigger occurs, trade suspension zone arrangements take effect immediately. The suspension zone arrangements remain in place until a period passes during which no further flies are trapped or otherwise found. This 'reinstatement' period is currently one generation and twenty-eight days, or twelve weeks, whichever is longer, after the last detection of a fly in the trapping network.

Detections of one or two male flies do not trigger outbreak declaration under the COP. If two flies are detected, the COP recommends but does not require, larval searches and additional traps. However, if a single fly or two flies were caught in Tasmanian traps, additional trapping, larval searches and an outbreak response would nonetheless occur, as made evident by the February 2011 event.

⁸ Retail and food services sales include imported and locally produced fruit

Temperature modelling suggests active, mature adult Queensland fruit flies could be present in Tasmania between December and April, with activity and numbers peaking in late summer. Although adult numbers are likely to be small, it cannot be assumed that these would not be detected in traps, or that outbreak trigger levels would not be reached. In addition, local fruit infestation, which is another outbreak trigger, is possible. Hence, suspension of trade in Tasmanian fruit is plausible. Indeed, in February 2011, China suspended trade in Tasmanian apples in response to the detection of two male flies in traps.

It is highly likely that small Queensland fruit fly occurrences would not persist to the next production season due to cold and/or eradication efforts. Furthermore, because the industry is dispersed across northern, north western and southern regions, trade suspension is unlikely to affect all regions simultaneously, and is likely to be confined to warmer areas.

Notwithstanding modelling predictions, whether State area freedom could be regained by the next fruit production season is unclear and hinges on the extent to which the CoP recognises patterns of fruit fly life stage development in cool temperate areas. Calculation of re-instatement periods under the CoP is being reviewed at this time. The method of summing Day-Degrees to achieve 1 generation in the revised CoP may or may not yield very long generation times for Tasmania. Even if a new re-instatement calculation kills all immature stages in Tasmania over winter, it may also yield very long maturation times for overwintered females, which could effectively spoil the following export season.

However, detection either above or below COP outbreak trigger levels could be expected to have some level of adverse impact on trade. It is difficult to ascribe a dollar value to state-wide fruit fly area freedom because it is not the only factor that determines market access, market demand or price premiums. Accordingly, it is equally hard to predict the magnitude of impact on trade should that status be compromised, even temporarily.

The \$55 million in fruit exports and the value of fruit supplied to Tasmanian businesses and consumers is modest on a state scale but regionally important. DPIPWE industry scorecards since 2004/05 reveal fruit trade is generally trending up which indicates overall, a healthy industry with growth potential.

Thus, the magnitude of Queensland fruit fly incursion impact associated with responses from domestic and international trade trading partners could be *significant* at a regional level but *minor* at the State level. **Impact score = E**

Effects on the environment including rural and regional economic viability

Tasmania has a 'small island economy' characterised by high openness to trade and reliance on specialised export activity (DPIPWE 2010). Primary industries are an important component of export growth. For example, in 2007/08 Tasmania generated a large food surplus, selling 74% by value into interstate and overseas markets. This is around double the proportion of food exported overseas by Australia as a whole (DPIPWE 2010). The food surplus was facilitated by average annual increases in production value of around 8% for the preceding decade, despite drought and global market instability (DPIPWE 2008). This level of steady growth highlights the strong export cultures that have developed in Tasmanian agricultural sectors, including fruit production, out of necessity.

However, reliance on a narrow range of exports renders Tasmania's economy more exposed to perturbations, compared with more economically diverse and populous jurisdictions. Perturbations can occur in the event of pest incursions, either through effects on production, or on market reputation. The latter may be exacerbated if a pest is iconic. Queensland fruit fly falls into this category.

Accordingly, the combined effects of Queensland fruit fly on Tasmanian producers and the small communities they live in are likely to be proportionately greater than impacts in more economically diverse mainland Australian jurisdictions. Cook *et al.* (2008) observe that for small rural communities already struggling to remain viable, pest incursions can be a tipping point.

Impact beyond small communities sustained by fruit production is also possible. Tasmania has established a strong brand that conveys place values that resonate with discerning markets. The Tasmanian Brand moderates economic disadvantage associated with the State's small size and distance from international markets (Eslake 2006). Biosecurity is at the core of the Tasmanian Brand, and since fruit flies are so well known, detection in Tasmania is unlikely to go unnoticed and has potential to undermine the brand values that the whole island looks to for product differentiation across a range of sectors.

Thus, the magnitude of Queensland fruit fly impact that could flow to the State's small island economy could be *highly significant* at a regional level and *significant* at the State level. **Impact score = F**

Overall magnitude of consequences

Using the impact aggregation rules outlined in Part Two, the overall magnitude of consequences of Queensland fruit fly entry, establishment and spread in Tasmania is **HIGH**.

3.3.4 UNRESTRICTED RISK ESTIMATE

Unrestricted risk for Queensland fruit fly, using the risk matrix at Table 5 in Part Two is estimated at:

VERY LOW L(EES) X HIGH (CONSEQUENCES) = LOW RISK

LOW risk exceeds Tasmania's Appropriate Level of Protection of VERY LOW. Therefore risk mitigation measures for host fruit from the Australian mainland are examined for potential to reduce the level of risk to VERY LOW.

3.4 PEST RISK ASSESSMENT FOR MEDITERRANEAN FRUIT FLY

3.4.1 PEST PROFILE

CURRENT VALID NAME

Ceratitis capitata (Wiedemann)

SYNONYMS

Ceratitis hispanica Brems

Tephritis capitata Wiedemann

Ceratitis citriperda MacLeay

Pardalaspis asparagi Bezzi

ORIGIN

Mediterranean fruit fly is native to sub-Saharan Africa and now occurs on five continents (De Meyer *et al.* 2002). It is reported to have spread to many countries in Europe in the first half of the 1900s but records in southern France date back to at least 1772 (Fimiani 1989). Mediterranean fruit fly was detected in New Zealand in 1996 but did not establish (SriRamaratnan 2009).

AUSTRALIAN DISTRIBUTION

Mediterranean fruit fly has a restricted distribution in Australia. The first record is from Western Australia in 1896 (Permkam & Hancock 1995) where it is now established from Esperance in the south to Derby in the north, with the largest populations occurring between Bunbury and Carnarvon (Vera *et al.* 2002). Outbreaks occur periodically in South Australia (Maelzer *et al.* 2004). Transient populations occurred in the Northern Territory, Queensland, New South Wales, Victoria and Tasmania, mostly in the early twentieth century. Mediterranean fruit fly is now absent from these jurisdictions (Permkam 1994).

HOSTS⁹

Acca sellowiana (Feijoa); *Actinidia deliciosa* (Kiwifruit); *Annona squamosa* x *A. cherimolia* (Custard Apple); *Averrhoa carambola* (Star Fruit; Carambola); *Capsicum annuum* (Capsicum and Chilli); *Carica papaya* (Papaya, Paw Paw); *Citrus aurantiifolia* (Lime); *Citrus aurantium* (Seville Orange); *Citrus grandis* (Shaddock; Pummelo); *Citrus latifolia* (Tahitian Lime); *Citrus limon* (Lemon; Meyer Lemon); *Citrus limon* x *C. chinese* (Lemon; Meyer Lemon); *Citrus medica* (Citron, Tangor); *Citrus meyeri* (Meyer Lemon); *Citrus paradisi* (Grapefruit; Pink Grapefruit); *Citrus reticulata* (Mandarin; Tangelo, Tangerine); *Citrus reticulata* var. *austera* (Rangpur Lime); *Citrus sinensis* (Sweet Orange); *Citrus tangelo* (syn. *C. reticulata* x *C. paradisi*) (Tangelo); *Coffea* spp. (including various Coffee); *Cydonia oblonga* (Quince); *Cyphomandra betacea* (Tamarillo, Tree Tomato); *Diospyros decandra* (Persimmon); *Euphoria longan* (Longan); *Ficus carica* (Fig); *Fortunella* spp. (Kumquat); *Litchi chinensis* (Lychee);

⁹ List comprises most common hosts and should not be read as a full host list

Malpighia glabra x *M. puniceifolia* (Acerola); *Malus domestica* (Apple); *Mangifera indica* (Mango); *Morus nigra* (Mulberry); *Musa spp.* (Banana, Plantation Banana); *Olea europaea* (Olive); *Passiflora edulis var. edulis* (Purple Passionfruit); *Passiflora edulis var. flavicarpa* (Yellow Passionfruit); *Persea Americana* (Avocado); *Phoenix dactylifera* (Date Palm); *Physalis peruviana* (Cape Gooseberry); *Prunus armeniaca* (Apricot); *Prunus avium* (Sweet Cherry); *Prunus domestica* (Plum); *Prunus domestica x armeniaca* (Plumcot); *Prunus persica* (Peach); *Prunus persica var. nectarine* (Nectarine); *Prunus persica x nucipersica* (Peacherine); *Prunus salicina* (Japanese Plum) *Psidium cattleianum (=littorale)* (Strawberry Guava; Cherry Guava); *Punica granatum* (Pomegranate); *Pyrus communis* (Pear); *Pyrus pyrifolia* (Nashi Pear); *Rubus spp.* (Blackberry, Raspberry, Loganberry, Boysenberry, Youngberry); *Solanum lycopersicum* (Tomato); *Solanum melongena* (Eggplant); *Solanum muricatum* (Pepino); *Vaccinium corymbosum* (Blueberry); *Vitis vinifera* (Grape).

Sources: CABI 2007, White & Hancock 1997, Hancock *et al.* 2000, CoP 1996.

3.4.2 LIKELIHOOD OF ENTRY, ESTABLISHMENT AND SPREAD

LIKELIHOOD OF ENTRY

Importation: Mediterranean fruit fly is polyphagous and attacks many types of commercially traded fruit in Australia. Tasmania imports around 25 000 tonnes of various host fruit from the Australian mainland each year. However, most fruit is imported from eastern Australian production regions where Mediterranean fruit is not present.

Quality management in contemporary commercial fruit production can be expected to ameliorate but not eliminate the chance of Mediterranean fruit fly larvae in imported produce. Routine crop monitoring, and in-line fruit grading, sorting and inspection is likely to result in removal of fruit showing signs of infestation. However, Mediterranean fruit fly 'stings' are not always visible and infected fruit can show no outward signs. Hence, infestation may not be detected during consignment preparation or on-arrival inspection.

Transit times are generally short, meaning fruit can be available to consumers anywhere in Australia in a matter of days after harvest. Short time from harvest to consumer also reduces the likelihood of infestation being detected, especially in late-stung fruit. Cool storage during transit to markets may slow egg and larval development but is unlikely to be applied long enough to cause mortality.

Transient populations of Mediterranean fruit fly occurred in Launceston in 1899 and 1920-21, and probably in Hobart in 1921 (ASD 1922, Lea 1899). Mediterranean fruit fly larvae have also been intercepted at the Tasmanian barrier in imported mainland fruit. However, no interceptions have been made since 1938.

Distribution: Imported host fruit is sold and distributed for consumption at multiple locations across Tasmania. Infested fruit could be discarded to compost heaps, roadsides, or landfill where larvae could emerge and pupate. Host plants are present in all inhabited parts of Tasmania.

Taking into account importation and distribution factors, particularly the limited mainland occurrence of Mediterranean fruit fly, the likelihood of it entering Tasmania in commercially produced host fruit is estimated at **VERY LOW**.

LIKELIHOOD OF ESTABLISHMENT

Like Queensland fruit fly, potential for Mediterranean fruit fly to establish in Tasmania is determined primarily by heat accumulation relative to life-stage threshold temperature requirements. However, although Mediterranean fruit fly is known to be restricted by low temperatures (e.g. Escudero-Colomar *et al.* 2008), it has significantly lower temperature developmental thresholds than Queensland fruit fly.

The thresholds adopted here are those determined by De Lima (2008), the most recent studies on the life cycle parameters of this species in Australia. These are 9.3°C, 11.1°C and 8.4°C for egg, larval and pupal stages respectively, and 12.8 °C for maturation of the adult stage. A different set of thresholds is proposed in the draft Mediterranean fruit fly Code of Practice (10.0°C for eggs-larvae, 11.6°C for pupae, and 15.7°C for maturation of adults), with higher Day-Degree requirements (Anon. 2008a). The CoP thresholds were investigated for application in this review but the De Lima thresholds were used in preference for two reasons.

First, the CoP thresholds suggest that Mediterranean fruit fly could not produce a single local generation of adults in Launceston in an average year, which would make a population of this species less viable in Tasmania than Queensland fruit fly. This is inconsistent with studies that indicate Mediterranean fruit fly occurs over a larger climatic range than Queensland fruit fly, and therefore is likely to be more cold tolerant (e.g. White & Elson-Harris 1992, Vargas *et al.* 2000, Duyck & Quilici 2002).

Second, modelling must be able to account for the outbreak and overwintering of Mediterranean fruit fly in Launceston in 1921. Reports from this time indicate that Mediterranean fruit fly had spread “everywhere throughout the city”, at least from Newstead to Trevallyn (a distance of 4 km and separated by a river) and was “practically all over the city” (ASD 1922). Furthermore, residents’ testimonies indicate the pest was present in fruit that had been picked before the infestation was recorded by government authorities. Even during the very warm period of this time, using the CoP thresholds and assuming larvae were imported early in spring, only one generation of local adults could have been produced with these adults reaching maturity only two weeks before this large

and widespread infestation was recorded. Modelling using the De Lima thresholds on the other hand, shows that two local generations could have been produced before this outbreak, with the second generation maturing some five weeks before the outbreak was recorded. Assuming that the infestation developed not from imported larvae but from an undetected overwintering population, there could have been two and three local generations for the CoP and De Lima thresholds respectively. Whatever the source of the outbreak, the De Lima thresholds provide a better account of the apparently large and widespread infestation that occurred in 1921.

Lower development thresholds for Mediterranean fruit fly mean the potential period of nil development in the cool season is shorter relative to Queensland fruit fly and that the period of inactivity that adult flies must endure is also shorter. Lower thresholds also increase the probability of a few individuals surviving short winters, as occurs in northern Greece (Papadopoulos *et al.* 2001).

Again, using Launceston as the most favourable location for a summer outbreak, the potential for Mediterranean fruit fly to occur transiently or become established in Tasmania is investigated by modelling the fate of fully grown larval cohorts hypothetically imported in fruit each month of the year. The simple Day-Degree model used to investigate the establishment potential of Queensland fruit fly is employed again, i.e.

$$\text{Day-Degrees} = ((T_{\text{max}} \text{ } ^\circ\text{C} + T_{\text{min}} \text{ } ^\circ\text{C}) / 2) - \text{developmental threshold } T^\circ\text{C}$$

As for Queensland fruit fly, the modelling assumes that if adult flies tried to overwinter in Launceston, they would resorb eggs and mature again in the following season. The modelling also takes into account cool periods when development is unlikely and the probable impact of these periods on life stages not adapted to sustained dormancy.

It is also assumed there are no other impediments to life cycle completion apart from temperature – i.e. larvae remain viable in imported, infested fruit, the fruit is discarded to a site that is otherwise suitable for pupation, emergent adults find shade, food and water to attain maturity and mate, and mated females find host fruit in which to deposit eggs.

The modelling results (Figure 3) suggest the following seven scenarios for mature larvae hypothetically imported into Launceston.

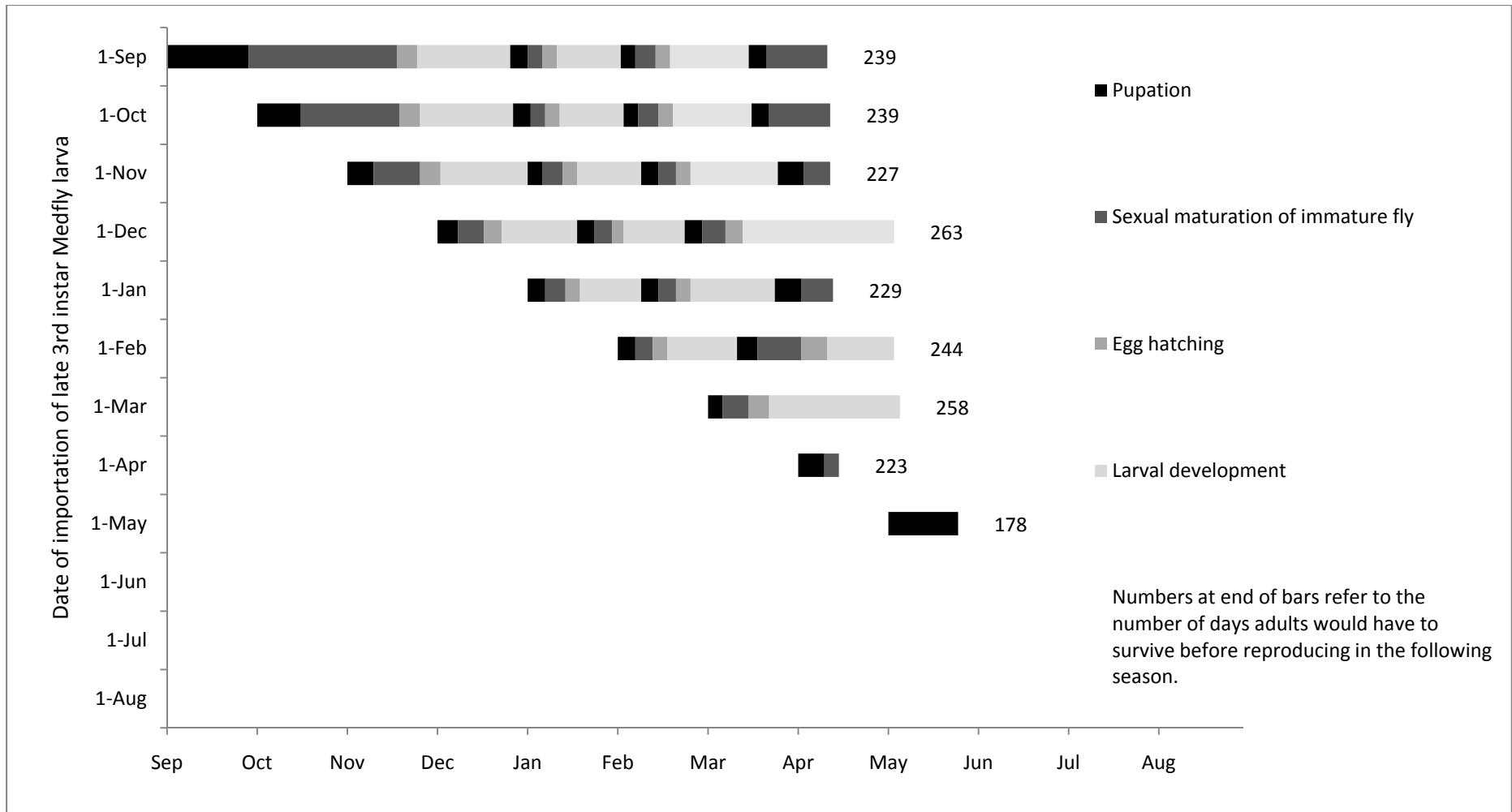


Figure 3 - Predicted life cycles and stages arising from fully grown larval cohorts of Mediterranean fruit fly imported into Launceston in fruit at the start of each month

Scenario 1: Larvae imported at the beginning of **June, July and August** would probably experience 1-3 months of temperatures at which no or very little growth is likely. These larvae are therefore unlikely to develop into adult flies. Mediterranean fruit fly larvae and pupae are not adapted to remain dormant for long periods. Hence, larvae entering in June, July and August are likely to perish from cold soon after, or if they pupate, soon after that.

Scenario 2: Larvae imported at the beginning of **September, October and November** could successfully pupate and emerge as immature adult flies in late September, mid-October and mid-November respectively. Larvae introduced in these months could result in three local generations, with the first local generation of adults emerging in early January, the second generation in mid-February and the third generation emerging from late March. This third generation would be unable to reach sexual maturity and hence would probably attempt to overwinter in April or May.

Actively reproducing flies typically live 2-3 months in warm parts of Australia, but during April or May in Launceston, survivors are likely to enter a sedentary overwintering state, after daily average temperatures fall below the developmental thresholds of all life stages. It is highly unlikely that these adult flies could survive over 220 days from emergence to mid-November when a second round of sexual maturation could be completed.

Scenario 3: Larvae imported at the beginning of **December** could develop into immature flies within a week. These flies would probably be mature enough to seek mates and lay eggs from mid-December onward. Larvae introduced in December could give rise to two local generations, with the first local adults emerging in late January, and the second in early March. This second generation might mature and lay eggs, but larvae arising from these eggs would probably be unable to pupate and would perish over winter. Surviving adults would probably enter an overwintering stage during April or May, and again would be unlikely to survive the 260 days from emergence to sexual maturity in the following season.

Scenario 4: Larvae imported at the beginning of **January** could emerge as flies within a week. These flies would probably be mature enough to seek mates and lay eggs from mid-January onwards. Larvae introduced in January would probably give rise to only two local generations, with the first local adults emerging in mid-February, and the second in early April. This second generation would be unlikely to reach sexual maturity, and hence would attempt to overwinter in April or May. It is unlikely that these adults would survive over 220 days from emergence to sexual maturity in the following season.

Scenario 5: Larvae imported at the beginning of **February** could emerge as flies within a week. These flies would probably be mature enough to seek mates and lay eggs from mid-February onwards. Larvae introduced in February would probably give rise to one local

generation, with adults emerging from mid-March. These adults might mature and lay eggs. However, larvae hatching from these eggs would probably be unable to pupate and would perish over winter. Surviving adults would probably enter an overwintering stage during April or May, and again would be unlikely to survive over 240 days from emergence to sexual maturity in the following season.

Scenario 6: Larvae imported at the beginning of **March** could emerge as flies within a week. These flies would probably be mature enough to seek mates and lay eggs from mid-March onwards. However, larvae hatching from these eggs would probably be unable to pupate and would perish over winter. Surviving adults would probably enter an overwintering stage during April or May, and again would be unlikely to survive over 250 days from emergence to sexual maturity in the following season.

Scenario 7: Larvae imported at the beginning of **April and May** could successfully pupate, with adults emerging in mid-April and late-May respectively. However, adults arising from either of these cohorts would be unlikely to reach sexual maturity, and hence would be unable to mate and lay eggs in local fruit. Adults emerging in mid-April would be unlikely to survive over 220 days from emergence to sexual maturity in the following season. Adults emerging in late-May would have a shorter period to survive until the following season, but this would still be more than 170 days.

Discussion: The modelling suggests that Launceston could support up to three local generations¹⁰ of Mediterranean fruit fly per year. Hence, a population of active flies between October and April, with numbers rising by January is plausible. However, individuals from any generation are unlikely to persist over the subsequent winter and initiate the next cohort, meaning each generation is likely to be transient. The shortest overwintering period is likely to be experienced by adults arising from larvae introduced into Launceston in early May. These flies would need to survive for at least 160 days before being able to reproduce in the following warm season. This is unlikely.

It follows that in parts of Tasmania characterised by less heat in the warm season than Launceston, such as the Huon Valley, Derwent Valley, North-west Coast and Hobart, there is likely to be less opportunity for three local generations. However, transient populations of fewer generations are possible in all fruit growing areas of the state. Most adult flies arising from a local generation at Tasmanian sites outside Launceston would need to survive for 220-260 days before being able to reproduce in the following warm season. This is unlikely, except in the circumstances described next.

¹⁰ Wherein a local generation starts with eggs and ends with the next cohort of eggs laid.

The lower pupal developmental threshold (8.4°C) for Mediterranean fruit fly compared with Queensland fruit fly (11.5°C) increase the chance that a pupal population might successfully overwinter in Tasmania in areas with winter temperatures that are milder than Launceston. Although Launceston offers more summer heat for Mediterranean fruit fly population increase than Hobart, the latter offers winter temperatures marginally more favourable to pupae bridging the cool season, albeit with high mortality.

Larvae imported into Launceston at the latest time available for growth (early May) would be unlikely to complete the pupal stage because they would face nearly 60 consecutive days over winter in which temperatures are suboptimal for pupal development. However, in Hobart the longest consecutive period of nil pupal development over winter is 5 days. Larvae imported into Hobart in May could successfully pupate in a year of average temperatures and subsequently develop into adults. The total period spent as pupae would be approximately 40 days, with immature adults emerging in June. These adults would still need to survive for over 150 days before maturing and mating in spring, with substantial attrition likely over that period. Hence, permanent establishment in Tasmania of Mediterranean fruit fly is more likely than for Queensland fruit fly, especially under favourable conditions.

Establishment prospects under warmer conditions? Under a higher temperature scenario of a one degree increase in daily minima and maxima, the period of nil pupal development in Launceston is shortened from 60 days to 10 days. In Hobart, where average temperatures would remain above 8.4°C throughout winter, pupal development would not be arrested at any time. Larval growth is also extended until the end of May. This means Mediterranean fruit fly larvae imported at the end of May could successfully pupate in Launceston and Hobart, with immature adults emerging in July. These adult flies would need to survive at least 120 days in Launceston and 115 days in Hobart before being able to reproduce and lay eggs. This is plausible.

Temperature modelling assuming warmer conditions helps explain why Mediterranean fruit fly successfully overwintered in Launceston from 1920-21, albeit with significant population mortality, and became extinct the following year. This period was compared with the present using the simple Day-Degree formula.

Temperatures during the 1920's outbreak were higher than both the 1961-90 average and the 2000-10 average (Figure 4). Mean maximum temperatures over summer 1920-21 were higher than the 2000-10 average, but similar for the remainder of the year. Mean minimum temperatures however, were substantially higher than the 2000-10 average for most of the year, and especially so over the winter period when populations are most at risk of being extinguished due to cold stress. The population declined dramatically in number over summer 1921-22 and disappeared by the next winter season.

In 1920 in Launceston there were 7 consecutive days of nil pupal development over winter. In 1921 there were 12 consecutive days of nil development. In 1921, Mediterranean fruit fly could have completed pupation in late July, with adults only needing to survive 110 days before reproducing and laying eggs in spring. Despite successfully overwintering in this year, the population appears to have experienced high attrition and eventually died out. Control measures were apparently applied but discontinued relatively early.

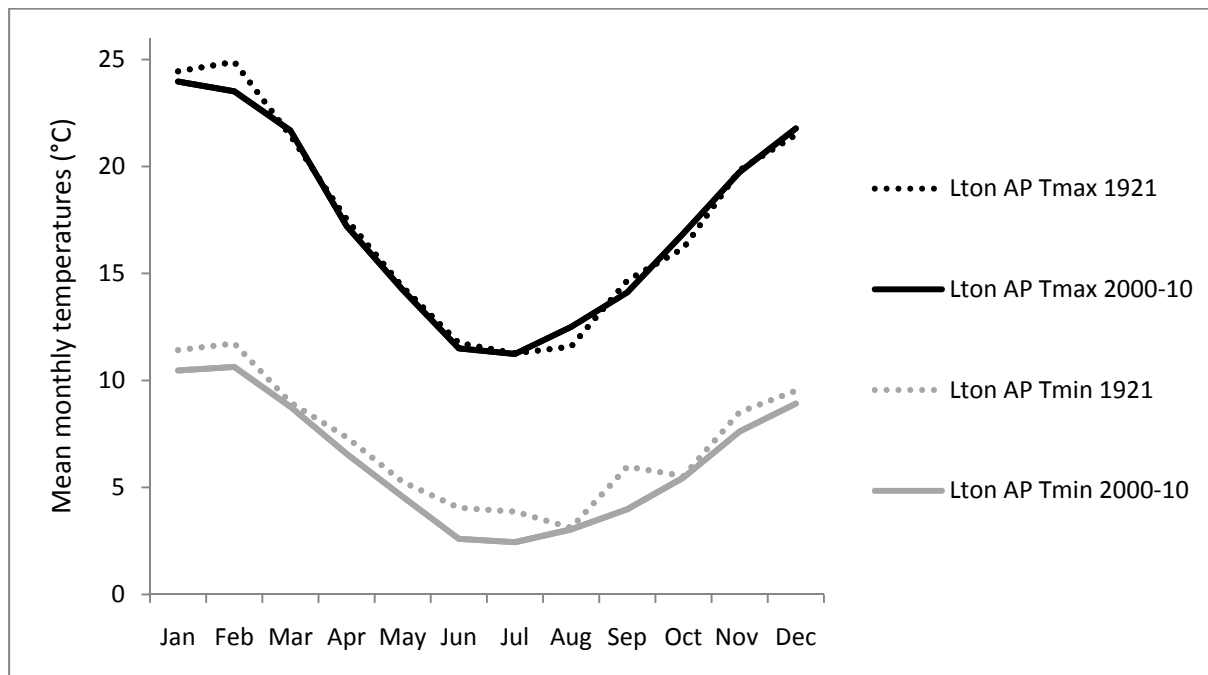


Figure 4 - Comparison of temperatures for Launceston (airport or airport corrected) during Mediterranean fruit fly occurrence in Launceston, 1921 and decade 2000-10 (Bureau of Meteorology)

Overall summary: The modelling indicates that Mediterranean fruit fly is unlikely to establish in Launceston under current conditions but could overwinter successfully during a warmer than average winter and hence establish the following spring. As up to three generations appear possible during current warm season conditions, and notwithstanding that winter attrition would still occur, a breeding population in the spring following a warm winter could be noticeable. Mediterranean fruit fly could also successfully overwinter in Hobart under favourable climatic conditions and hence establish the following spring. However, as fewer generations are possible in current warm season conditions than in Launceston, and because winter attrition would occur, the breeding population in Hobart in spring would be small, unless conditions in the previous spring were also warmer than average.

Given the above, the likelihood of Mediterranean fruit fly establishing in Tasmania is estimated at **MODERATE**.

LIKELIHOOD OF SPREAD

The main mechanisms by which Mediterranean fruit fly could move from a place of establishment in Tasmania are natural adult dispersal or transport of larvae in infested fruit by people. Movement by wind or adult hitchhiking on vehicles is unlikely.

Mediterranean fruit fly is less dispersive on the wing than Queensland fruit fly. However, the likelihood of its spread in Tasmania is greater because up to three local generations of flies could occur meaning more flies would be available to be carried around the state in fruit by people.

In addition, a larger proportion of the state is climatically suitable so that spread to cooler horticultural districts would be more likely to result in new establishment rather than extinction, as is the likely fate of Queensland fruit fly in those areas.

The likelihood of Mediterranean fruit fly spreading in Tasmania is therefore estimated at **MODERATE**.

LIKELIHOOD OF ENTRY, ESTABLISHMENT AND SPREAD L(EES) LARVAE:

Using the combination rules described in Part Two, the likelihood of Mediterranean fruit fly entering, establishing and spreading in Tasmania is:

VERY LOW X MODERATE X MODERATE = VERY LOW L(EES)

3.4.3 MAGNITUDE OF CONSEQUENCES

Direct Consequences:

If Mediterranean fruit fly were to enter, establish and spread in Tasmania in the way outlined in the previous section, two types of direct consequence are possible.

Impact on plant life and health:

Like Queensland fruit fly, potential impacts of Mediterranean fruit fly on plant health and life in Tasmania is unlikely to be limited by availability of hosts. In addition, the dispersed nature of production areas and Tasmania's population mean Mediterranean fruit flies arising from imported fruit could move or be moved from urban areas or small towns to production areas.

Temperature modelling indicates Mediterranean fruit fly could establish populations in Tasmania that could persist. Hence, damage to host fruit, while likely to be less than that experienced in Western Australia and potentially other places on the Australian mainland, could nonetheless occur at noticeable levels.

Populations of adult flies are possible in Tasmania between October and April, with adult numbers and activity levels peaking in late summer. Immature flies do not sting fruit and their feeding habits are unlikely to damage plants. However, mature flies which deposit eggs into fruit could be present between November and April. Populations are likely to suffer attrition over winter in Tasmania but may not perish altogether. To that extent, impacts could be considered irreversible. Small local populations could be supplemented by recruitment from additional infested imported fruit.

Thus, direct impacts of Mediterranean fruit fly on host plants in Tasmania are likely to be *significant* at the regional level and *minor* at the State level. **Impact score = E**

Impact on any other aspects of the environment

Mediterranean fruit fly could have adverse effects on parts of the environment other than introduced fruit trees, in the same way that Queensland fruit fly may have. However, Mediterranean fruit fly is also mostly known as a fruit production pest. Absence of reported damage in native plants in Western Australia suggests damage to native vegetation in Tasmania may be minimal.

In Tasmania, direct effects of Mediterranean fruit fly on the environment, other than host plants, are likely to be *minor* to *indiscernible* at regional and State levels respectively. **Impact score = D**

Indirect Consequences

Taking into account the types of direct consequence that could occur if Mediterranean fruit fly were to enter, establish and spread in Tasmania, four types of potential indirect impacts are possible.

Costs of eradication and control

Mediterranean fruit fly populations could persist in Tasmania over more than one season, especially if winters were mild, and build to levels that facilitated detection in the trapping network or in local fruit. Eradication efforts would ensue immediately.

The recent costs of eradicating outbreaks of Mediterranean fruit fly in South Australia range between \$103,000-\$206,000 per outbreak, based on 2-4 outbreaks per year (Maelzer *et al.* 2004). This figure is likely to reflect proficiencies and efficiencies accumulated in government, industry and the community from years of experience in responding to fruit fly outbreaks.

Detection of Mediterranean fruit fly would trigger Tasmanian State biosecurity emergency response arrangements, coordinated from a State Control Centre and informed by the State contingency plan for fruit fly incursions (DPIPWE in draft). While Tasmania has response coordination capacity for any type of pest outbreak, interstate expertise would be sought to help ensure on-ground operations were effective and efficient.

Hence, eradication costs for Mediterranean fruit fly are likely to be of a similar magnitude to those incurred in South Australia, somewhat higher for the first outbreak and reducing as local expertise developed.

If a government coordinated eradication response was not mounted or failed, Tasmanian producers could be expected to incur additional costs in the form of disinfestation treatments, pre-harvest sprays, and production losses. A review of the tri-state fruit fly strategy estimated \$150 per tonne for cold and/or chemical disinfestation, and \$120 per hectare for pre-harvest chemical control (PWC 2001).

Since pre-harvest chemical regimes are rarely 100% effective, residual production loss can be expected. Mumford *et.al* (2001) estimated potential production losses for select fruit crops from Mediterranean fruit fly in Western Australia without and with use of control measures in orchards, under ideal climatic conditions. Potential production losses in the absence of control measures ranged from 0.05% in grapes to 0.4% in stonefruit, with an average loss of around 0.22%. Potential losses after application of control measures were 10% of losses without control.

Application of these loss rates to the \$86 million farm gate value of Tasmanian horticulture in 2007/08, equates to \$18.9 million in lost production without control and \$1.9 million in lost production with control. Since Tasmania does not have ideal conditions for Mediterranean fruit fly, losses can be expected to be substantially smaller. It is difficult to reliably estimate how much smaller the losses might be. Nonetheless, even if loss rates were reduced ten-fold, the total cost is in the order of \$200 000 per year. Pre-harvest control and disinfestation costs that would also apply under this scenario would increase that estimate.

Thus, the magnitude of impact associated with eradication and control of Mediterranean fruit fly in Tasmania could be *significant* at the regional level and *minor* at the State level.

Impact score = E

Effects on domestic and international trade

Detection of Mediterranean fruit fly in Tasmania has potential to affect domestic and international trade in the same way, and through the same trade suspension arrangements as discussed for Queensland fruit fly.

Although the magnitude of Mediterranean fruit fly impact, associated with responses from domestic and international trade trading partners, could be expected to be larger than that of Queensland fruit fly due to better establishment potential, market impact is unlikely to be irreversible. Thus, impacts of Mediterranean fruit fly on domestic and international trade can be expected to be *significant* at a regional level but *minor* at the State level. **Impact score = E**

Effects on the environment including rural and regional economic viability

The same observations made for Queensland fruit fly in relation to impact on Tasmania's small rural communities and brand values apply to Mediterranean fruit fly.

However, some higher and discernible level of indirect environmental and social impact resulting from greater levels of chemical use for responding to Mediterranean fruit fly is plausible. Mumford *et al.* (2001), in considering the Western Australian situation, assumed an environmental cost for Mediterranean fruit fly control of \$1 per \$1 spent on pesticides. Similarly, the cost to home gardeners in South Australia was assessed as part of a review of its management arrangements (van Velsen 1987). This report estimated the value of the annual backyard fruit production in Adelaide at over \$22 million, and that if South Australian eradication programs ceased, backyard production would decline by 80%, equating to a loss to the community of approximately \$18 million per year. The same types of social amenity impacts could be anticipated to occur in Tasmania, but not at the levels predicted for more populous States with more favourable climates.

Despite this additional potential for social amenity impact, the magnitude of Mediterranean fruit fly impact that could flow to the State’s small island economy is likely to be similar to that of Queensland fruit fly - that is, *significant* at the State level. **Impact score = F**

Overall magnitude of consequences

Using the impact aggregation rules outlined in Part Two, the overall magnitude of consequences of Mediterranean fruit fly entry, establishment and spread in Tasmania is **HIGH**.

3.4.4 UNRESTRICTED RISK ESTIMATE

Unrestricted risk for Mediterranean fruit fly, using the risk matrix at Table X in Part Two, is estimated at:

VERY LOW L(EES) X HIGH (CONSEQUENCES) = LOW RISK

LOW risk exceeds Tasmania’s Appropriate Level of Protection (ALOP) of VERY LOW. Therefore risk mitigation measures for host fruit from the Australian mainland are examined for potential to reduce the level of risk to VERY LOW.

The pest risk estimates for Queensland fruit fly and Mediterranean fruit fly are summarised in Table 9.

Table 9 - Pest risk estimate summary

	ENTRY	ESTABLISHMENT	SPREAD	L(EES)	CONSEQUENCES	RISK	RISK MITIGATION WARRANTED?
Queensland fruit fly	MODERATE	LOW	LOW	VERY LOW	HIGH	LOW	YES
Mediterranean fruit fly	VERY LOW	MODERATE	MODERATE	VERY LOW	HIGH	LOW	YES

3.5 PEST RISK MANAGEMENT

3.5.1 IDENTIFICATION AND ASSESSMENT OF RISK MANAGEMENT OPTIONS

Sections 3.3 and 3.4 demonstrate that risk posed by Queensland fruit fly and Mediterranean fruit fly associated with commercial fresh fruit produced on the Australian mainland and in the absence of specific risk mitigation measures is LOW and therefore exceeds Tasmania's ALOP of VERY LOW. Thus, pest risk management is warranted.

Although ISPM 11 notes pest risk management can be applied pre-border, border and post-border, in this review risk management evaluation is limited to pre-border phytosanitary options provided in the current Import Requirements (Table 10), plus any new measures approved by Domestic Quarantine and Market Access Working Group (DQMAWG) since the Import Requirements were formulated. As outlined in Part One, the five Import Requirements relating to post-harvest dipping or flood spraying with dimethoate and fenthion, and any ICA protocol concerning pre-harvest treatments with either of those chemicals are not examined due to the APVMA review situation.

Table 10 - Tasmanian import requirements for fruit fly host produce

Import Requirement	Title
1	Area Freedom for Queensland Fruit Fly (<i>Bactrocera tryoni</i> (Froggatt)) and Mediterranean Fruit Fly (<i>Ceratitis capitata</i> (Wiedemann))
2A	Treatment with Dimethoate (400 ppm and 200 ppm) for Qfly
2B	Treatment with Fenthion (412.5 ppm) for Qfly
3A	Treatment with Fenthion (500 ppm) for Medfly (Tamarillo fruit)
3B	Treatment with Fenthion (412.5 ppm) for Medfly (Tomato fruit)
3C	Treatment With Fenthion (412.5 ppm) for Medfly (Mango and Capsicum fruit)
4A	Fumigation with Methyl Bromide (Qfly, Medfly)
4B	Methyl Bromide Fumigation Plus Cold Treatment For Qfly (Avocado fruit)
5	Cold Sterilisation (Qfly, Medfly)
6A	Heat Treatment for Qfly and Medfly (Avocado fruit)
6B	Heat Treatment for Qfly (Mango fruit)
6C	Heat Treatment for Qfly (Papaya/Papaw/Pawpaw Fruit)
7A	Condition or Maturity for Qfly (Hard Green Condition Papaya and Banana fruit)
7B	Condition or Maturity for Qfly (Mature Green Condition Tomato, Babaco, Banana, Black Sapote, Papaya, Passionfruit, Tahitian Lime fruit)
7C	Condition or Maturity for Qfly (Unbroken Skin Mangosteen, Lychee, Longan, Rambutan fruit)
8A	Condition or Maturity for Medfly (Hard Green Condition Banana fruit)
8B	Condition or Maturity for Medfly (Mature Green Condition Banana and Tomato fruit)
8C	Hard Green Condition for Medfly (Avocado fruit)

Excluding dimethoate and fenthion options, the current Import Requirements provide for five types of phytosanitary measure. These are:

- Area freedom
- Treatment with methyl bromide
- Cold treatment
- Heat treatment
- Conditional status

New phytosanitary measures for fruit flies approved by the DQMAWG since the current Import Requirements came into effect concern:

- Irradiation
- Systems approach for strawberries from South East Queensland

These options are assessed for capacity to reduce the risk of each species from LOW to VERY LOW. The technical basis for each Import Requirement is examined, with reference to relevant national protocols. For the area freedom Import Requirement, the fruit fly CoPs are the relevant national protocols. For Import Requirements involving disinfestation, conditional status or a systems approach, Interstate Certification Assurance (ICA) protocols developed by the DQMAWG are relevant.

If a phytosanitary measure, in its current form or with adjustment, appears sufficient to reduce risk from LOW to VERY LOW, adoption is recommended and strategies for monitoring on-going effectiveness are identified.

This section concludes the pest risk analysis. Proposed revised Import Requirements, as they would appear in Tasmania's *Plant Quarantine Manual* follow in Part Four.

3.5.2 AREA FREEDOM – IMPORT REQUIREMENT 1

Relevant national protocols: National Code of Practice for Managing Queensland Fruit Fly (Anon. 1996) and Draft National Code of Practice for Managing Mediterranean Fruit Fly (Anon. 1996)

Both Codes of Practice (CoPs) and the combined version currently being drafted specify arrangements for establishing and maintaining pest free areas for Queensland fruit fly and Mediterranean fruit fly in Australia.

The CoPs include rules for monitoring and validating area freedom and for controlling movement of host produce into production areas managed to exclude fruit flies. The CoPs define outbreak parameters and specify delimitation, eradication and notification procedures that must occur if fruit flies are detected. The CoPs provide for trade in host produce from areas managed to exclude fruit flies in the event of outbreaks, according to four rules:

1. **Outbreak Areas:** *Host produce from outbreak areas cannot be traded unless specifically approved by the relevant State or Territory authority.*

For both species, an outbreak area is the area within a 1.5km radius of a fruit fly discovery point. Discovery points are either trees on which infested fruit is found, or trap sites at which flies have been caught. If multiple discovery points occur and are close by, an outbreak epicentre is determined. Pest free status is revoked within outbreak areas.

2. **Suspension Zones:** *Produce may be traded from within a suspension zone provided it is subject to an approved disinfestation treatment.*

A trade suspension zone is the area within a radius of a discovery point or outbreak epicentre that extends beyond the outbreak area. Suspension zone size is larger for Queensland fruit fly outbreaks than for those involving Mediterranean fruit fly because the flight distance of the latter is typically smaller. In addition, suspension zone size is based on assumptions about whether outbreak flies originate from a single source or multiple sources.

For Queensland fruit fly outbreaks, a suspension zone of 15km applies if there is either one discovery point or several occurring less than 1 km apart and within two weeks. Flies detected within 1km of each other within two weeks are assumed to have originated from the same source. Flies detected at sites more than 1km apart are assumed to have originated from different sources and a 30km suspension zone applies around the epicentre. For Mediterranean fruit fly outbreaks, suspension zone

size is 7.5km for single source outbreaks or 15km for multiple source outbreaks. Pest free status is revoked within suspension zones for both flies.

3. **Pest Free Areas:** *Produce may be traded without disinfestation from any part of an area managed to exclude either fruit fly provided it does not fall within any suspension zone in place in that area.*

That is, pest free status is maintained.

4. **Reinstatement of pest free status:** *For both flies, pest free status for suspension zones, including outbreaks areas, is reinstated 1 generation and 28 days, or 12 weeks after the last fly is caught or detected, whichever is longer.*

This rule assumes pest monitoring and other area free maintenance and validation activities continue to take place according to the relevant CoP specifications.

Of the four CoP rules for trade out of fruit fly free areas during outbreaks, 2 and 4 are directly relevant to the assessment of Import Requirement 1. Both rules are based on experimental findings and modelling results relating to fly biology, particularly dispersal behaviour and life cycle. Both rules are subject to on-going discussion in national plant health fora. The technical basis for each rule and some of the main issues being considered in national discussions are outlined below.

Rationale for CoP suspension zone size:

The technical basis for suspension zone size is derived from expert judgement about fruit fly flight informed particularly by fruit fly mark-recapture studies, outbreak experience, resource availability theory and dispersal modelling. The rationale for suspension zone size also assumes that outbreaks in designated fruit fly free areas are likely to be transient, infrequent, and hence eradicable because:

- habitat is marginally suitable; and
- effective control on carriage of infested host fruit into those areas is feasible; and
- the trapping network is sufficient to detect flies soon after their arrival; and
- endemic populations are small or distant enough not to impose significant, constant propagule pressure.

The main assumptions about fruit fly flight and outbreak transience and infrequency are examined below.

Flight: Understanding the natural dispersal ability and behaviour of pests is fundamental to setting quarantine zones that provide for effective outbreak containment and eradication while also maintaining confidence that host product traded from within, or from areas

adjacent to those zones, is free of viable pests. The relevant dispersal parameters for fruit flies in outbreak situations relate to adult flight. They concern flight distance, dispersal pattern, and the consequences of both for subsequent population establishment.

Flight distance: Most information about how far fruit flies can fly comes from mark-recapture studies involving release of experimental flies from a defined point around which a trapping grid has been established, or from outbreak trapping data. The trapping results provide information about maximum flight capability.

Mark-recapture studies specific to Queensland fruit fly in Australia, and which report maximum flight distances from release sites have been collated by Dominiak (in prep). These are: Swan (1949) (1.6km); Monro & Richardson (1969) (0.4km*); Fish (1955) (1.2km); Andrewartha *et al.* (1967) (3km¹¹); Fletcher (1974) (22.7km); MacFarlane *et al.* (1987) (94km); Bateman (1991) (0.73km); Reynolds *et al.* (1995) (2.5km*); Dominiak & Webster (1998) (1.0km), Meats (1998a) (0.2km*), Dominiak *et al.* (2000) (0.5km); Dominiak *et al.* (2003a) (1km); Dominiak *et al.* (2003b) (<5km); Meats & Edgerton (2008) (1km); Weldon & Meats (2010) (1.1km).

Mediterranean fruit fly is generally accepted as being less dispersive than Queensland fruit fly. Baker and Chan (1991) found few Mediterranean fruit flies moved beyond their 50m trapping array. Plant and Cunningham (1992), using a 733m trapping grid, found about 80% of flies stayed within 300m of the release site. Meats *et al.* (2003) in examining trapping data from 75 outbreaks in area free zones in Australia concluded Mediterranean fruit flies were unlikely to travel more than 1km from an introduction site. Occurrences beyond 1km were rare and deemed to be due to separate introductions. Fletcher (1989) however, reported movement over more than 20km. Israely *et al.* (2005a and 2005b) suggest Mediterranean fruit fly can move at least 50km in the Negev Desert.

The results above suggest collectively that Queensland fruit fly may be capable of long distance flight to around 100km but is more likely to make journeys of a kilometre or less. Mediterranean fruit fly also appears more likely to undertake short flights and its overall flight capability appears to be less than that of Queensland fruit fly.

However, such conclusions are uncertain to the extent that:

- different studies used different sized trapping grids, and therefore maximum recorded flight distances may reflect the limit of the grid rather than the limit of fly capability; and

¹¹ Maximum flight distance in brackets except for asterisked items which are the flight distance of >90% of released flies

- most mark-recapture studies deployed gamma-irradiated, mass-bred flies, circumstances that may impair flight capability compared with wild flies; and
- release numbers may have been too small to inform statistically reliable conclusions about flight capability; and
- fly recapture is not 100%, meaning some proportion of longer distance flights may have been undetected; and
- mark-recapture flies have been observed to hitch-hike on the vehicles of researchers travelling to check outer parts of their trapping grid.

Dispersal pattern: The inherent limitations of mark-recapture and outbreak trapping studies mean flight distance cannot by itself be used to set reliable quarantine zones for fruit flies. This prompted fruit fly dispersal theory development and modelling by Australian researchers and regulators, to help validate current settings and explore possibilities for reducing them and hence further minimising the disinfestation burden. The same efforts can also be used to test the significance to outbreak management of longer distance detections such as reported for Queensland fruit fly by Fletcher (1974) and MacFarlane *et al.* (1987) and for Mediterranean fruit fly by Fletcher (1989). Current dispersal theory for fruit flies combines physics and biology.

Fletcher (1974) in considering his recapture data, proposed an inverse square rule to explain Queensland fruit fly dispersal. Inverse square rules describe patterns of dilution radiating from a centre point, and are commonly applied to natural phenomena. Inverse square rules propose that the quantity or strength of a thing is inversely proportional to the square of the distance from the source of that thing (e.g. if distance X is doubled, quantity Y becomes one quarter of what it was at the source, if distance X is tripled, Y becomes one ninth of what it was and so on).

In the case of fruit flies, recapture data show that decreases in fly numbers with distance from a point of release or outbreak epicentre approximate an inverse square rule, with fly numbers remaining high near the source and declining quickly to very low numbers at longer distances in any direction in a given time. Fly density at the release site is also important. For example, from a release of over 1 million Queensland fruit flies such as that conducted by MacFarlane *et al.* (1987), dispersal of around 2km per day for about 50 days is theoretically possible. It can be inferred from this rate that the potential maximum reach of even a very dense infestation is around 100km, with 90% of flies remaining within about 800m of the source. Even fewer individuals would make long distance journeys from less dense infestations such as can be anticipated in an outbreak situation.

Subsequently, other researchers, after pooling and analysing many mark-recapture and outbreak trapping data sets (e.g. Meats & Edgerton 2008) proposed alternative, and perhaps more refined inverse power dispersal rules. However, high fly density around the

source and a rapid tailing off with distance remain the defining features. Other tephritid species exhibit the same basic dispersal pattern (Dominiak in prep).

The practical utility of inverse power rules has been validated by application to sterile male flies used in many eradication programs wherein it is critical to optimise the release rate and spacing. Meats *et al.* (2008) also showed events during the successful papaya fruit fly eradication program in north Queensland were well described by inverse power rules.

Dispersal modelling informed by mark-recapture and incursion trapping data is also supported by ecological theory. Fletcher (1989) suggested that movement of Mediterranean fruit fly is likely to correlate with resource availability, a view supported by De Lima (2008) who examined outbreaks in the Donnybrook area of Western Australia. Good food, shelter and water availability, either in urban or production areas, provides little incentive to move away. Consequently, when resources are plentiful short flights can be expected to be common, and longer flights will be rare. The frequency of longer flights can be expected to increase if resources become scarce. Dominiak (in prep.) proposes the same resource-based rationale for Queensland fruit fly flight distance and distribution.

Hence, dispersal modelling combined with resource availability theory appears to adequately explain observed trapping results, including those which imply long distance flight. It therefore provides sufficient confidence that trapping observations are likely to be a reasonable representation of actual fruit fly dispersal in outbreak situations.

Dispersal and population establishment: However, since long distance flight, though apparently rare, is also apparently plausible, the likelihood of individuals giving rise to populations far away from outbreak epicentres is also pertinent to setting quarantine zones.

Dominiak (in prep) ventures that long flights by Queensland fruit fly away from an outbreak epicentre to other parts of an otherwise fruit fly free area are unlikely to lead to successful reproduction and additional population establishment, even if food, water and shelter are not limiting. He suggests fruit flies largely disperse randomly and in the immature adult stage, whereupon they are likely to place themselves further from prospective mates than they were at the start of their journey. It follows that the further they fly, the less company they are likely to keep, and hence the less likely they are to be able to mate and initiate new populations. Gravid females are extremely unlikely to fly long distances.

Further, Meats & Edgerton (2008) point out that 71% of incipient incursions (one fly in a surveillance trap) expire without treatment, suggesting prospects of fruit fly success at low density are marginal. Meats (1998a) estimated that when there are 6 male and 6 female Queensland fruit fly present per hectare, a single mating is probable, and that the chance of a successful mating on the same tree is about 0.1%.

Hence, the likelihood of long distance fliers initiating new populations appears to be very modest.

Outbreak transience and frequency: On balance, the above suggests the 15km/30km and 7.5km/15km rules for trade suspension for Queensland fruit fly and Mediterranean fruit fly respectively are conservative. The CoP suspension zone settings are therefore likely to provide sufficient buffers against fruit flies escaping outbreak areas by flying out, and subsequently infesting host produce that could be traded without disinfestation, in additional parts of an otherwise fruit fly free area. Logically, the chance of this is further reduced by the permanent trapping grid deployed across designated fruit fly free production areas. That is, additional populations initiated from long distance fliers would still be subject to trapping, and hence detection.

However, the assumption that outbreaks in fruit fly free areas are likely to be transient or infrequent, and hence that outbreak measures will occur before potentially infested fruit is traded without disinfestation, is perhaps tenuous under certain conditions, at least for Queensland fruit fly.

This started to become apparent in season 1999/2000 which was characterised by widespread outbreaks of Queensland fruit fly in the FFEZ, particularly the Riverina region in New South Wales (Gilchrist 2004). More recently, an evaluation of statewide Queensland fruit fly management was commissioned by the Victorian Department of Primary Industries in response to a high number of outbreaks in that State in 2008/09 compared with previous years (i.e. 38 c.f. average of 12 p.a.), and the domestic market access disruption that followed (DPI 2010). The outbreaks caused an almost two-fold increase in Queensland fruit fly management costs in Victoria, escalating from \$4.46 million in 2007/08 to \$7 million in 2008/09 (Access Economics 2010). The outbreaks include parts of the FFEZ and are clustered in north-eastern and south-eastern Victoria, and in Melbourne (Kalang 2008). Season 2010/11 was also challenging, with Victoria and New South Wales recording 70 and 150 outbreaks of Queensland fruit fly respectively, particularly either side of the eastern border of the FFEZ (B. Dominiak *pers comm.*, G. D'Arcy *pers comm.* June 2011). A combination of plentiful moisture and warm temperatures is generally acknowledged to have favoured Queensland fruit fly population increases in eastern Australia during these periods (e.g. Gilchrist 2004, Kalang 2010).

Given the flight distance data and distribution modelling, it is reasonable to conclude that outbreaks are more likely to have been derived from larvae transported in infested fruit than from adult dispersal from endemic areas along the eastern seaboard. For example, B. Dominiak (*pers comm.* 2011), in examining fruit fly roadblock efficacy for the New South Wales portion of the FFEZ, notes fruit carriage rates by the travelling public of around 18% in situations where roadblocks had not previously been used. This suggests substantial, routine

fruit transport by citizens despite signs, fines, quarantine bins and other public awareness and enforcement activity. Dominak further estimates the proportion of fruit carried around by the public that also contains fruit fly larvae is in the order of 1/1000 in a humid year, and twice that likely to occur in a dry year.

Tracing the likely source of outbreak flies transported in infested fruit is complex. Perhaps the most informative investigation was conducted by Gilchrist (2004) who assembled a large database of Queensland fruit fly DNA from specimens collected over 2001-2004 from Brisbane to Wodonga to Alice Springs to the Western Slopes of New South Wales and within the New South Wales portion of the FFEZ. Using DNA microsatellite markers, he identified 8 source populations and concluded that most outbreaks in the New South Wales part of the FFEZ originated from nearby populations, particularly the population established in the Wagga-Wagga/Albury region, rather than from larger east coast populations further afield (e.g. Brisbane, Sydney).

Half the source populations in Gilchrist's 2004 study were in towns in the New South Wales portion of the FFEZ - Deniliquin, Hay, Leeton and Barooga, with Deniliquin being the main 'internal' source of outbreaks elsewhere in the FFEZ. These town populations have since been eradicated (B. Dominiak *pers comm.* July 2011). While Gilchrist (2004) did not investigate dispersal mechanisms directly, he identified local (i.e. backyard) fruit transport as a priority for further investigation. The study of fly genetics for Victorian and New South Wales outbreaks has recently resumed. Early indications (Dominiak *pers comm.* July 2011) are that these support Gilchrist's (2004) findings – i.e. that outbreak flies in the FFEZ are more likely to originate from local endemic populations than from distant ones.

The FFEZ has experienced periods of relatively high outbreak frequency over the last decade, and there is nothing to suggest this will not continue if conditions are conducive. Establishment of Queensland fruit fly within the FFEZ has also been demonstrated, and while these populations have been eradicated, the experience illustrates the management challenge and corresponding heightened potential for control failure.

Therefore, the reliability of 15km/30km suspension zones in preventing trade in infested fruit can be expected to be lower in humid, favourable seasons when outbreaks are more frequent and maintaining effective control becomes harder.

Rationale for reinstatement period

Reinstatement of pest free area status following an outbreak depends on proof of absence of fruit flies within the suspension zone. The proof of absence established under the CoP for each species is that one generation and 28 days or 12 weeks must pass after the last wild fly is captured in traps, or the last larva is found, whichever is longer. For the first option, generation times are calculated for a range of towns in New South Wales, Victoria and South

Australia for which there are long-term temperature data, using the same Day-Degree model applied in sections 3.3 and 3.4 of this review:

$$\text{Day- Degrees} = ((T_{\text{max}} \text{ } ^\circ\text{C} + T_{\text{min}} \text{ } ^\circ\text{C}) / 2) - \text{developmental threshold } T^\circ\text{C}$$

Developmental thresholds used to calculate generation time are modified from Fletcher (Anon. 1996a) for Queensland fruit fly and from the Californian Department of Food and Agriculture (Anon. 1996b) for Mediterranean fruit fly.

National debate about suspension zone size and reinstatement period:

Suspension zone size: As well as suggesting current suspension zone settings are adequate, dispersal modelling also implies that the size of an outbreak population, as indicated by the rate of trapping, could be used to determine suspension zone size. This concept has attracted interest nationally because it has potential to justify a more flexible approach to trade suspension, including reduction of current suspension zone settings at times when trapping indicates a low density outbreak.

MacFarlane *et al.* (1987) made two mass releases during warm weather at Wangaratta. Analysis of the first release shows they trapped 467 flies in 10 traps within 1km of the release site over the same nine week period that two flies were detected at 80-94km. In the second release, they trapped 207 flies in 10 traps within 1km of the release site and made one detection at 63km. If adjusted for increased trap density, these trapping rates are equivalent to catching many hundreds of flies in a dense cluster of 16 traps within 200m of the source.

Subsequently, Meats *et al.* (2003) applied an inverse square model to an analysis of historical data from 262 Queensland fruit fly larvae or adult detections in Adelaide (71% alerts or single detections, 29% outbreaks). Using a confidence limit of 99.997%, they tested the model against outbreak data from Western Australian, Victoria, New South Wales and other trap grids in South Australia and were able to predict the actual extent of those outbreaks without exception. Their data indicate that when trap catches remain below a certain threshold per fortnight in a set of 16 supplementary male lure traps deployed immediately after the first catch, and within a 200m radius of an outbreak epicentre, an 8km suspension zone is sufficient. The threshold for an 8km suspension zone indicated by most South Australian data is 25 flies, with a single trap catch suggesting 55 flies. The threshold for an 8km suspension zone indicated by data collected in other states is 35 flies.

Their results also imply that flies must be trapped at a rate of over 100 per fortnight in a set of 16 supplementary male-lure traps to justify a 15km suspension zone. G. D'Arcy (*pers. comm.* June 2011) indicated that a catch of 100 flies in a set of supplementary traps is rare in Victoria (0.1%) and would probably indicate presence of a second or third generation,

and/or control failure. B. Dominiak (*pers. comm.* July 2011) also advised that catches around 100 in New South Wales are likely to indicate control failure. Examples of this occurred in New South Wales in season 2010/11, and are attributed to bait inefficacy.

Dominiak (in prep.) has further elaborated knowledge of Queensland fruit fly dispersal to propose a 2km suspension zone when less than 10 flies are trapped over nine weeks in a set of 32 supplementary male-lure traps, and a 15km suspension zone when that rate is exceeded. This proposal assumes that supplementary McPhail wet traps currently specified under the CoP would be replaced by male-lure traps. B. Dominiak (*pers. comm.* June 2011) indicated that catches above 20 in a set of supplementary traps is a relatively high figure, not exceeded in New South Wales in unfavourable years.

Reinstatement period: Reinstatement period is being considered in the current review of the CoPs, including in regard to the calculation of generational time, and meaningfulness of the 12-week option. The overall thrust of these discussions is to explore ways of refining reinstatement time calculations so that confidence in fly eradication is maintained while trade without disinfestation is resumed as soon as possible.

In this context, it appears likely that the 12 week reinstatement option, which lacks a demonstrated basis in fly biology, will be removed from the CoPs.

Import Requirement 1: Area Freedom for Queensland Fruit Fly (*Bactrocera tyroni* (Froggatt)) and Mediterranean Fruit Fly (*Ceratitis capitata* (Wiedemann))

Import Requirement 1 currently specifies hosts of Queensland fruit fly and Mediterranean fruit fly, conditions for area freedom, and conditions for safe transit of host produce from fruit fly free areas through areas where fruit flies are present.

The host lists in Import Requirement 1 were updated in 2008 to reflect those in the CoPs. Some minor changes have been negotiated in DQMAWG since then. However, national debate about whether particular fruits are hosts, preferred hosts or minor hosts for both flies is on-going.

The area freedom conditions in Import Requirement 1 are that host fruit will only be accepted without treatment from a property that has been free of both flies for at least 12 months, and that all boundaries of that property must be more than 80km from any fruit fly occurrences. In the 1980s, Tasmania imposed a 120km fruit fly free buffer around properties from which fruit could be accepted without treatment. This was reduced to 80km in the 1990s.

In practice, the area freedom option prescribed in Import Requirement 1 is only available to fruit growers within mainland production areas managed according to the CoPs, such as the

FFEZ. The conditions mean that Tasmania applies an 80km/12 month trade suspension zone around outbreaks of either fly in areas otherwise managed according to the CoPs. These conditions are therefore inconsistent with two of the four trade rules in the CoPs.

The condition for safe transit is that host produce from fruit fly free areas must be transported in fruit fly-proof packaging or in a fruit fly-proof enclosure if it passes within 80km of the outer boundary of an area in which fruit fly occurs. In practice, this condition is applied in respect of any fruit fly detection on the Australian mainland, including in non-production areas. It has implications when consignments are deconsolidated in wholesale markets, during which the original fruit fly proof packaging is opened. If the wholesale market is within 80km of an outbreak, that part of a split consignment intended for Tasmania must be disinfested. The CoPs are silent on the matter of secure transit of fruit fly host produce.

Proposal for Import Requirement 1

Hosts:

Retain the current host lists for Queensland fruit fly and Mediterranean fruit fly in Import Requirement 1, and maintain consistency either with host lists in the respective CoPs or with updates to host status agreed in the DQMAWG.

Suspension zone size Queensland fruit fly:

Replace the 80km suspension zone in Import Requirement 1 with a 15km suspension zone for outbreaks when there is either one discovery point or several occurring less than 1 km apart, within two weeks. If the trapping rate exceeds 35 male flies within two weeks in permanent plus 16 supplementary Lynfield male-lure traps deployed within 200m of an outbreak discovery point or epicentre, the 15km suspension zone expands to 80km.

Adopt a 30km suspension zone when outbreak flies are detected at sites more than 1km apart. If the trapping rate exceeds 35 male flies within two weeks in permanent plus 16 supplementary Lynfield male-lure traps deployed within 200m of an outbreak discovery point or epicentre, the 15km suspension zone expands to 80km.

These settings recognise the weight of evidence behind the suspension zone settings in the CoP, are more conservative than 8km and 2km suspension zones indicated by Meats *et al.* (2003) data and proposed by Dominiak (in prep) respectively, and are more responsive to seasonal conditions which influence Queensland fruit fly population size and potential for outbreak control failure.

Suspension zone size Mediterranean fruit fly:

Replace the 80km suspension zone condition in Import Requirement 1 with a 7.5km suspension zone for outbreaks of Mediterranean fruit fly when there is either one discovery point or several occurring less than 1 km apart and within two weeks.

Adopt the 15km suspension zone when outbreak flies are detected at sites more than 1km apart.

These settings recognise the weight of evidence behind the suspension zone settings in the CoP, and are more responsive to seasonal conditions which influence population size and potential for outbreak control failure.

Reinstatement period:

Replace the 12 month reinstatement period in Import Requirement 1 with the proposed modified CoP reinstatement rule – i.e. that area freedom is reinstated one generation and 28 days after the last fly is caught in a trap or the last larvae is detected.

Consignment security:

Replace the current conditions for consignment security in Import Requirement 1 with conditions that align with those specified in several ICA protocols for fruit fly (see below). These are that host produce must be:

Packaged in:

- Unvented packages; or
- Vented packages with vents secured with gauze/mesh with a maximum aperture of 1.6mm; or
- Palletised units sealed with shrink-wrap; or

If not packaged as above, host produce must be stored such that it is:

- Held in fully enclosed or screened buildings, cold rooms, vehicles or other facilities free from gaps or other entry points greater than 1.6mm.

The revised Import Requirement 1 should note that produce destined for Tasmania that is removed from secure packaging or storage during consignment deconsolidation in commercial mainland fruit markets, must be resecured as soon as possible.

Restricted Risk

Trade suspension zone arrangements according to the proposed Import Requirement 1 can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in host fruit from MODERATE and VERY LOW respectively to at least EXTREMELY LOW.

Unrestricted risk for both flies can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

3.5.3 TREATMENT WITH METHYL BROMIDE – IMPORT REQUIREMENTS 4A AND 4B

Relevant Interstate Certification Assurance Protocol

ICA - 04 (Version 3.0) Fumigation with methyl bromide:

Methyl bromide is a pesticidal chemical widely used as a fumigant for post-harvest phytosanitary treatment of plants and plant products. Tolerances to methyl bromide differ between species and with life stage (Armstrong & Whitehand 2005). A considerable amount of efficacy data has been generated for Tephritid fruit flies and methyl bromide schedules have been developed as a result (Armstrong *et al.* 1984, Armstrong and Whitehand 2005).

ICA-04, last updated in 2009, provides for fumigation of fresh produce for Queensland fruit fly, Mediterranean fruit fly and a range of other quarantine pests specified by States and the Northern Territory. ICA-04 specifies the operational principles, design features and standards required for fumigation facilities, and the responsibilities and actions of personnel at those facilities.

ICA-04 contains the following methyl bromide fumigation regimes, applied at normal atmospheric pressure for 2 hours:

Fruit Core Temp °C	Rate g/m³
10 – 10.9	56
11-15.9	48
16-20.9	40
21 +	32

Kalang (2010) note that ICA-04 operational protocols include a caveat that fumigation may not result in 100% fruit fly egg or larval mortality, and that fruit that is known to be infested with fruit fly should not be treated with methyl bromide.

ICA-04 also specifies post-fumigation consignment security for Tasmania. The same secure storage conditions appear in other fruit fly ICAs, although sometimes the conditions apply to all States and the Northern Territory. Secure storage is achieved when host produce is:

Packaged in:

- Unvented packages; or
- Vented packages with vents secured with gauze/mesh with a maximum aperture of 1.6mm; or
- Palletised units sealed with shrink-wrap; or

If not packaged as above, host produce must be stored such that it is:

- Fully enclosed under tarpaulins, hessian, shade cloth, mesh or other covering which provides a maximum aperture of 1.6mm; or
- Held in fully enclosed or screened buildings, cold rooms, vehicles or other facilities free from gaps or other entry points greater than 1.6mm.

Import Requirement 4A - Fumigation with Methyl Bromide (Qfly, Medfly): Import Requirement 4A specifies a treatment schedule that was previously consistent with that in ICA-04 i.e.

Fruit Core Temp °C	Rate g/m³
10 – 14.9	48
15-20.9	40
21-25.9	32
26-31.9	24

However, since ICA-04 was recently updated to be consistent with Australian Quarantine and Inspection Service rates, the regime in Import Requirement 4A no longer aligns with ICA-04. Adoption of the AQIS rates overall provides for higher dosages of methyl bromide to be applied at the lower end of the temperature range within which methyl bromide fumigation is effective (10°C), and at the higher end (21°C+). As there is no information from Tasmanian quarantine barrier inspections or barrier surveillance conducted by other jurisdictions to suggest the previous schedule was not generally effective, it is unlikely that the new schedule will be any less efficacious.

Import Requirement 4A applies to all Queensland fruit fly and Mediterranean fruit fly host produce except bananas and avocados. ICA-04 does not contain these exclusions, and the technical basis is uncertain. In addition, Import Requirement 4A requires Defective Flower End Papaya (also known as 'solo' type papaya or red papaya) to be in a mature green condition prior to fumigation. ICA-04 does not impose this additional requirement. The morphology of Defective Flower End papaya, which allows Queensland fruit fly to deposit directly into the centre of the fruit, renders it more vulnerable to fruit fly attack. However, there is nothing to suggest that fumigation efficacy is influenced by maturity.

Import Requirement 4A contains a condition for post-treatment consignment security that is less explicit than measures described in ICA-04. This may create ambiguity. Import Requirement 4A does not refer explicitly to ICA-04 which may also create ambiguity for importers and exporters.

Proposal for Import Requirement 4A:

- Adopt updated methyl bromide dosage schedule in ICA-04;
- Remove footnote excluding bananas and avocados;

- Remove reference to Defective Flower End Papaya;
- Include post-treatment consignment security options consistent with ICA-04;
- Clarify that produce may be either certified by a business accredited to use ICA-04 or by an approved person who can attest that fumigation has occurred in full accord with IR 4A;
- Specify that methyl bromide treatment must not be applied to fruit known to be infested with Queensland fruit fly or Mediterranean fruit fly.

Restricted risk

Methyl bromide treatment according to the revised Import Requirement 4A can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in host fruit from MODERATE and VERY LOW respectively to at least EXTREMELY LOW.

Unrestricted risk for both flies can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

Import Requirement 4B – Methyl Bromide Fumigation plus Cold Treatment for Queensland fruit fly (Avocado)

Import Requirement 4B specifies methyl bromide fumigation at a rate consistent with ICA-04, plus storage after fumigation for 11 days at 7°C. The technical basis for this regime is not clear. Import Requirement 4B is likely to reflect product quality factors that are matters for exporters and importers to consider when selecting which phytosanitary option to apply.

Proposal for Import Requirement 4B:

- Revoke

3.5.4 COLD TREATMENT – IMPORT REQUIREMENT 5

Relevant Interstate Certification Assurance Protocol

ICA-07 (version 2.1) Cold treatment disinfestation for fruit fly

Cold treatment is used to reduce the temperature of host produce to below the thermal limit of survival for a pest. ICA-07, last updated in 2010, provides for cold disinfestation of host fruit of fruit flies, and specifies the operational principles, design features and standards required for cold treatment facilities, and the responsibilities and actions of personnel at those facilities. ICA-07 covers facility and equipment testing and calibration, operational procedures, including post-treatment security, and documentation requirements. Cold treatment regimes for Queensland fruit fly and Mediterranean fruit fly as agreed by DQMAWG are in Table 11.

Table 11 - Cold disinfestation treatment for fruit flies ICA-07

Fruit core temperature at treatment start	Treatment duration (days)
Queensland Fruit Fly.	
0°C ± 0.5 °C	14
1.0°C ± 0.5 °C	16 (lemons 14)
2.0°C ± 0.5 °C	16 (lemons 14)
3.0°C ± 0.5 °C	16 (lemons 14)
Mediterranean Fruit Fly.	
0°C ± 0.5 °C	14
1°C ± 0.5 °C	16 (lemons 14)
2°C ± 0.5 °C	18 (lemons 16)
3°C ± 0.5 °C	20 (lemons 18)

In addition, cold treatment schedules are being developed as an Annex to ISPM 28 (*Phytosanitary Treatments for Regulated Pests*). Schedules in the draft annex for Queensland fruit fly and Mediterranean fruit fly in various citrus fruit are based on the work of De Lima *et al.* (2007) and data submitted by Argentinean authorities. The draft schedules are consistent with the regime in Table 11, with the exception of grapefruit. Argentine data suggests disinfestation of grapefruit is efficacious at 2°C for 19 days or at 3°C for 23 days – longer periods than those specified in Table 11.

Import Requirement 5 – Cold sterilisation (Qfly, Medfly):

Import Requirement 5 contains cold treatment temperatures that align with those in ICA-07. There is no information from Tasmanian quarantine barrier inspections or barrier surveillance conducted by other jurisdictions to suggest the schedules are not generally effective. However, the treatment durations for Queensland fruit fly in Import Requirement 5 do not align with ICA-07, and are generally less demanding. The technical basis for the differences between Import Requirement 5 and ICA-07 is not clear.

DQMAWG obtained advice on the regimes in Table 11 from one of the co-authors of the De Lima *et al.* (2007) paper. It is unclear whether the grapefruit/Mediterranean fruit fly data provided by Argentine authorities was discussed. This is worth noting to DQMAWG for future consideration, at which time Import Requirement 5 can be further adjusted if necessary.

Import Requirement 5 also permits the importation of peeled, frozen-seeded mango that is hard frozen on arrival. This permission would appear superfluous.

Proposal for Import Requirement 5:

- Adopt the cold disinfestation schedules in ICA-07;
- Include post-treatment consignment security options as for Import Requirement 1;

- Specify that cold treatment must not be applied to fruit known to be infested with Queensland fruit fly or Mediterranean fruit fly;
- Clarify that produce may be either certified by a business accredited to use ICA-07 or by an approved person who can attest that treatment otherwise occurred in full accord with ICA-07;
- Remove the condition permitting peeled, frozen seeded mango;
- Replace the term ‘cold sterilisation’ in the Import Requirement title, with ‘cold disinfestation’.

Restricted risk

Cold treatment according to the revised Import Requirement 5 can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in host fruit from MODERATE and VERY LOW respectively to at least EXTREMELY LOW.

Unrestricted risk for both species can therefore be expected to be reduced to VERY LOW, meaning Tasmania’s ALOP is met.

3.5.5 HEAT TREATMENT – IMPORT REQUIREMENTS 6A, 6B AND 6C

Relevant Interstate Certification Assurance Protocols

ICA-05 (version 1) Vapour Heat Treatment of Mangoes and ICA-10 (version 3) Hot Water Treatment of Mangoes:

Post-harvest heat treatments have emerged as a viable non-chemical phytosanitary method for fruit flies, in particular for mango fruit (Corcoran *et al.* 2000, Heather *et al.* 1997, Jacobi *et al.* 2001). Fruit is heated to a specified core temperature for a defined length of time via vapour heat (Heard *et al.* 1992), forced hot air (Heather *et al.* 2002) or hot water immersion (Heard *et al.* 1991, Jacobi *et al.* 2001, Sales *et al.* 1996). Experimental work suggests Mediterranean fruit fly is among the more heat tolerant tephritids (Gazit *et al.* 2004).

Several authors (e.g. Laidlaw *et al.* 1996, Osman *et al.* 1996, Beckett and Evans 1997, Follet & Neven 2006) note that efficacy of heat treatments may be compromised by thermal pre-conditioning and acclimation. Thermal pre-conditioning is a physiological response by either a pest or its host to natural environmental change. Acclimation describes an organism’s capacity to respond to short-term or acute thermal change. Hence, heat treatments developed using insects reared under stable laboratory temperatures that are subsequently applied to wild insects, may be not be as efficacious because the latter may be pre-conditioned by high field temperatures. Rapid heating may also reduce the lethality of heat treatments, particularly for fruit flies (Armstrong *et al.* 1995).

ICA-05 (Vapour Heat Treatment of Mangoes under AQIS Supervision) applies to Queensland fruit fly and requires mangoes to be treated by vapour heat in an approved facility at:

- 46.5°C for a minimum of 20 minutes; or
- 47.0°C for a minimum of 15 minutes.

ICA-10 (Hot Water Treatment of Mangoes) applies to Queensland fruit fly and requires mangoes to be immersed in hot water at an approved facility such that the temperature of the flesh adjacent to the seed is at 46°C for at least 10 minutes.

ICA-05 and ICA-10 also specify facility requirements, facility and equipment testing and calibration, operational procedures, including post-treatment security, and documentation requirements.

The technical justification for the treatments in the two ICAs is not apparent. Further, the hot water treatment specification is very different from that required by the United States Department of Agriculture (USDA) for mango fruit. The USDA requires 65-110 minutes at approximately 46°C, depending on mango shape and weight, apparently based on Sharp (1988) who tested *Anastrepha* spp. and Mediterranean fruit fly. Sharp (1988) demonstrated variations in mortality times between species at probit 9 (LT99.9968) of up to 40 minutes.

More recent studies (e.g. Armstrong *et al.* 2009) indicate the USDA immersion time may be unnecessarily long. However, other studies (e.g. Gazit *et al.* 2004) appear to verify some of the USDA times. Work by Waddell *et al.* (2000) suggests that the LT99.9968 for Queensland fruit fly in water at 46°C is 18.6 minutes. Western Australia requires a 20 minute hot water treatment for mangoes.

Moreover, in January 2010 two consignments of mangoes certified under ICA-10 and sent to Tasmania were found on arrival to be infested with live Queensland fruit fly larvae. Subsequent investigation suggested the heat treatment had been performed correctly and according to ICA-10, casting doubt on ICA-10 hot water treatment efficacy.

Import Requirement 6A - Heat treatment for Qfly and Medfly (Avocado)

There is no corresponding ICA for Import Requirement 6A which requires avocados to be dipped in water at 46°C for 3 minutes prior to continuous storage at 1°C ± 0.5°C for 16 days.

The origin of this Import Requirement probably lies in earlier work by that showed chilling injury in avocados could be reduced if cold disinfestation was preceded by a warm water dip with 500ppm benomyl (Jessup 1991, 1994). Products containing benomyl are no longer registered for use in Australia but alternative products that can help precondition avocados to reduce chilling injury during cold disinfestation are available (Sanxter *et al.* 1994, Nishijima *et al.* 1995). Use of these products is a matter for exporters.

Hence, Import Requirement 6A does not constitute heat treatment for phytosanitary purposes.

Proposal for Import Requirement 6A

- Revoke

Import Requirement 6B – Heat Treatment for Qfly (Mango)

Import Requirement 6B is consistent with ICA-05 and ICA-10. However, the efficacy of ICA-10 is doubtful, given the literature generally indicates longer exposure times at 46°C are required to reliably achieve mortality. Detection of live Queensland fruit fly larvae in mangoes imported to Tasmania under this protocol supports an argument for longer treatment times.

Proposal for Import Requirement 6B

- Amend the condition for hot water immersion such that the temperature of the flesh adjacent to the seed is at 46°C for a minimum of 20 minutes, or another time longer than 10 minutes and at least 20 minutes as agreed by DQMAWG;
- Include post-treatment consignment security options as for Import Requirement 1;
- Specify that heat treatment must not be applied to fruit known to be infested with Queensland fruit fly or Mediterranean fruit fly;
- Clarify that produce may be either certified by a business accredited to use ICA-05 or by an approved person who can attest that treatment occurred in full accord with ICA-05.

Restricted risk

Heat treatment according to the revised Import Requirement 6B can be expected to reduce the likelihood of Queensland fruit fly entry in mango fruit from MODERATE to at least EXTREMELY LOW.

Unrestricted risk for both species can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

Import Requirement 6C – Heat Treatment for Qfly (Papaya/Pawpaw)

There is no corresponding ICA for Import Requirement 6C which requires firm-fleshed papaya (also known as papaw, pawpaw) to be subject to high temperature forced air for at least 3.5 hours and until the seed cavity reaches a temperature of 47.2°C.

Although this Import Requirement applies to Queensland fruit fly, it appears that this treatment was developed from tests on Mediterranean fruit fly and two other fruit fly species not present in Australia (Armstrong *et al.* 1995). However, temperature tolerance experiments suggest that this treatment would also be effective on Queensland fruit fly

(Beckett and Evans 1997). Import Requirement 6C is not currently used by exporters, probably due to lack of high temperature forced air infrastructure in Australia. However, this situation may change as chemical phytosanitary options become less available.

Proposal for Import Requirement 6C

- Expand to cover Mediterranean fruit fly
- Include post-treatment consignment security options as for Import Requirement 1;
- Specify that heat treatment must not be applied to fruit known to be infested with Queensland fruit fly or Mediterranean fruit fly.

Restricted risk

High temperature forced air treatment according to the revised Import Requirement 6C can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in papaya fruit from MODERATE and VERY LOW respectively to EXTREMELY LOW.

Unrestricted risk for both species can therefore be expected to be reduced to VERY LOW, meaning Tasmania’s ALOP is met.

3.5.6 CONDITIONAL STATUS OF HOST FRUIT – IMPORT REQUIREMENTS 7A, 7B, 7C, 8A, 8B AND 8C

Relevant Interstate Certification Assurance Protocols

Seven ICAs for fruit fly provide for conditional status of host fruit as a phytosanitary option. The ICAs for host conditional status are listed in Table 12. ICA-06 applies to Cavendish bananas and ICA-16 applies to all bananas (*Musa* spp.), however there does not appear to be any practical difference between the two in terms of conditional status requirements. Hence, they are considered together below.

Table 12 - ICAs for host conditional status

ICA	Name	Species	Hosts
ICA-06 Ver 3	Hard Green Condition of Bananas	<i>B. tryoni</i> , <i>B. aquilonis</i> , <i>B. neohumeralis</i> and <i>B. Musae</i>	Cavendish bananas
ICA-08 Ver 4	Mature Green Condition and Immature Green Condition of Papaw and Babaco	<i>B. tryoni</i> , <i>B. aquilonis</i> and <i>B. neohumeralis</i>	Papaya and babacos
ICA-13 Ver 3	Unbroken Condition of Approved Fruits	<i>B. tryoni</i> , <i>B. aquilonis</i> and <i>B. neohumeralis</i>	Durian, Jaboticaba, Jackfruit, Longan, Lychee, Mangosteen, Rambutan and Pomegranate
ICA-15 Ver 2	Mature Green Condition of Passionfruit, Tahitian Limes and Black Sapotes	<i>B. tryoni</i> , <i>B. aquilonis</i> and <i>B. neohumeralis</i>	Passionfruit, Tahitian Limes and Black Sapotes
ICA-16 Ver 1	Certification of Mature Green Condition of Bananas	<i>B. tryoni</i> , <i>B. aquilonis</i> , <i>B. neohumeralis</i> and <i>Ceratitidis capitata</i>	<i>Musa</i> spp.

ICA-27 Ver 1	Mature Green Condition of Tomatoes	<i>B. tryoni</i>	Tomato
ICA-30 Ver 5	Hard Green Condition of Avocado	<i>Ceratitis capitata</i>	Hass, Sharwil and Fuerte avocados

Female fruit flies are less likely to deposit eggs in hard, immature fruit than softer, ripe fruit (Messina *et al.* 1991, Pena *et al.* 1986) although immature fruit may become infested if the skin is split or broken. Host-specific information underpins this general observation. For example, Hancock *et al.* (2000) note that fruit flies are not known to infest hard green bananas. Hancock *et al.* (2000) identify tomato as a host for Mediterranean fruit fly only when overripe or damaged. Balagawi *et al.* (2005) note Queensland fruit fly will attack ripe tomatoes, which reasonably implies green tomatoes are less attractive as hosts. Several authors report experimental or produce inspection results that indicate certain varieties of avocados at the mature green stage are not a host of Mediterranean fruit flies (e.g. Armstrong *et al.* 1983, Liquido *et al.* 1995, Messina *et al.* 1991, Pena *et al.* 1986). De Lima (1995, 2000, 2010) used cage experiments to test Hass, Sharwill, Fuerte and Reed avocados grown in Western Australia for susceptibility to Mediterranean fruit fly infestation. In Reed avocados, oviposition occurred but did not lead to further development of eggs, or larvae. The experiments demonstrated hard green condition is an effective quarantine measure for avocado in respect of Mediterranean fruit fly.

Import Requirements for host conditional status

Six Import Requirements offer host conditional status as a phytosanitary option. Three apply to Queensland fruit fly and three apply to Mediterranean fruit fly. The Import Requirements are:

- **Import Requirement 7A Condition or Maturity for Qfly (Hard Green Condition)** which applies to papaya and banana. It is consistent with ICA-08 and ICA-16, the latter of which also applies to Mediterranean fruit fly.
- **Import Requirement 7B Condition or Maturity for Qfly (Mature Green Condition)** which applies to tomato, babaco, banana, black sapote, papaya (non-defective end types), passionfruit, and Tahitian lime. It is consistent with ICA-08, ICA-15, ICA-16, and ICA-27. It should be noted that ICA-27 requirements in respect of tomato include a pre-harvest cover spray in addition to conditional status.
- **Import Requirement 7C Condition or Maturity for Qfly (Unbroken skin)** which applies to mangosteen, lychee, longan and rambutan. It is consistent with ICA-13 except that the latter now also covers jaboticaba, pomegranate, durian and jackfruit.

- **Import Requirement 8A Condition or Maturity for Medfly (Hard Green Condition)** which applies to banana. It is consistent with ICA-16.
- **Import Requirement 8B Condition or Maturity for Medfly (Mature Green Condition)** which applies to banana and tomato. It is consistent with ICA-16 in respect of bananas. There is currently no ICA for tomato condition in respect of Mediterranean fruit fly.
- **Import Requirement 8C Hard Green Condition for Medfly** which applies to Haas, Sharwell and Fuerte avocados. It is consistent with ICA-30, except that the latter has been updated to include Reed avocados.

There is no indication from Tasmanian quarantine barrier inspections or barrier surveillance conducted by other jurisdictions to suggest the schedules are not generally effective, noting tomato is not covered for Mediterranean fruit fly by any ICA.

Proposal for Import Requirement 7A, 7B, 7C, 8A, 8B and 8C

- Consolidate the six Import Requirements into a single Import Requirement for host conditional status;
- Add jabotica, pomegranate, durian, jackfruit and Reed avocados to current host produce permitted import on the basis of conditional status;
- Include post-treatment consignment security options as for Import Requirement 1;
- Clarify that produce, as relevant, may be either certified by a business accredited to use ICA-06, ICA-08, ICA-13, ICA-15, ICA-16, ICA-27 or ICA-30 or by an approved person who can attest that treatment occurred in accord any of those ICAs, as relevant.

Restricted risk

Host conditional status according to the revised Import Requirement outlined above can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in several fruit from MODERATE and VERY LOW respectively to EXTREMELY LOW.

Unrestricted risk for both species can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

3.5.7 IRRADIATION

Relevant Interstate Certification Assurance Protocol

ICA-55 Irradiation Treatment

Ionising radiation, or irradiation, disrupts the chemical bonds in cellular molecules, including DNA. Arthropods and other organisms subject to larger doses of irradiation are rendered

sterile or inactive, or die, hence its use as a post-harvest phytosanitary measure (e.g. Hallman 1999). Tolerance to irradiation varies widely between species and with species' life stage.

ISPM No. 18 (*Guidelines for the use of irradiation as a phytosanitary measure*) (FAO 2003) notes that the treatment objective can be mortality, arrested development (e.g. non-emergence of adults), sterility or inactivation. It identifies sterilisation as appropriate for pests that are not vectors of other pests, and remain on or in the commodity. Fruit flies are likely to be an example for which doses that achieve sterility are sufficient. ISPM also summarises literature for estimated minimum absorbed doses for phytosanitary purposes for specific groups of pests. The estimated minimum absorbed dose required to prevent adult emergence from the third larval instar of fruit flies is 50-250 Gy. For tephritid fruit flies, data from studies of 17 economically important pest species of *Anastrepha*, *Bactrocera*, *Ceratitis* and *Rhagoletis* have been used to determine that a dose of 150 Grey (Gy) is effective for quarantine purposes (Follet 2009). For *Ceratitis* and *Bactrocera*, sterilization of larvae is achieved between 50 and 110 Gy (Bakri 2002). 150Gy is sufficient to cause non-emergence in treated eggs and larvae of Queensland fruit fly and Mediterranean fruit fly (Bustos *et al.* 2004, Heather *et al.* 1991).

ICA-55 describes principles for operation, design features and standards required for irradiation facilities, consistent with ISPM No. 18, and responsibilities and actions of personnel. It specifies a minimum absorbed dose of 150 Gy for fruit flies of the family Tephritidae, as well as minimum absorbed doses for other quarantine pests. ICA-55 applies only to fresh fruit and vegetables approved for irradiation by Food Standards Australia and New Zealand (FSANZ).

Proposal for New Import Requirement

- Adopt irradiation as a treatment for fruit fly host produce in accord with ICA-55

Restricted Risk

Irradiation treatment according to the Import Requirement outlined above can be expected to reduce the likelihood of Queensland fruit fly and Mediterranean fruit fly entry in host fruit from MODERATE and VERY LOW respectively to EXTREMELY LOW.

Unrestricted risk for both species can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

3.5.8 SYSTEMS APPROACH – CITRUS FROM QUEENSLAND

Relevant Interstate Certification Assurance Protocol

ICA-28 Pre-harvest treatment (bait spraying) and inspection of citrus (version 3)

ICA-28 describes a systems approach for mitigating the risk of Queensland fruit fly in mandarins, tangors, oranges, limes, grapefruit and lemons, excluding Meyer lemons. The protocol, which has been in use since 1999, takes effect between 1 March and 25 August each year and is available to growers from defined production areas in Queensland. The defined production areas are:

- Central Burnett, Emerald and inland areas of Queensland west of the coastal ranges and south of latitude 22°S; and
- Coastal areas of Queensland east of the coastal ranges and south of latitude 24°30'S and north of latitude 26°S.

The systems approach comprises pre-harvest measures including property plan development, pre-harvest protein bait spraying of commercial and non-commercial host trees with Naturalure™, chlorpyrifos, malidison or trichlorfon, and a pre-harvest trapping program to support the bait spraying. Post harvest measures include identification and traceability arrangements, grading and packing conditions, packed product inspection requirements, and arrangements for non-conforming product.

ICA-28 is underpinned by several linked studies since the late 1990s, mostly conducted in the Central Burnett district, one of Queensland's major citrus production areas. Lloyd *et al.* (2000) estimated infestation levels in commercial orchards that used bait spray consistently were in the order of 0.029-0.047% at the 95% confidence level. Subsequently Lloyd *et al.* (2009) compared several evaluations of fruit fly activity level across the year based on trap catches. These indicate Queensland fruit fly and other fruit fly activity is seasonal in the Central Burnett district and declines to very low levels between March and August, falling to around zero between April and July (Lloyd *et al.* 2009). The March-August period coincides with that of main citrus ripening and harvest in the Central Burnett district.

In addition, since 2004 an Area Wide Management program has been underway in the Central Burnett district. The AWM program uses year round Male Annihilation Technique (MAT) devices to further reduce fruit fly pressure, particularly during peak activity times (i.e. outside the period specified in ICA-28). Lloyd *et al.* (2009) found trap catches during peak activity times fell by 95% compared with trap catches before the AWM program was initiated. Hence, it is reasonable to conclude the AWM program is likely to reduce overall Queensland fruit fly pressure in the Central Burnett district, and therefore lends additional confidence in the ability of ICA-28 to reduce the likelihood of viable larvae in citrus.

Fruit fly activity and pressure in the coastal citrus production area specified in ICA-28 has not been studied to the extent of the Central Burnett district. However, research on one variety of lemon (Eureka) and two varieties of mandarin (Imperial, Murcott) in 2000 using the same trapping and fruit inspection methods indicates Queensland fruit fly population

levels follow similar temporal patterns to those in the Central Burnett district. Experimental trapping confirmed coastal citrus production areas around Childers and Tiaro have greater fly population pressure than the Central Burnett district, and accordingly trap catches were generally higher and did not fall to zero (QHI 2001).

However, the purpose of trapping under ICA-28 is to monitor fly pressure and hence allow growers to adjust the level of bait spraying accordingly. The experimental fruit sampling regime, designed to detect infestation at 0.1%, indicated that field control, even when trap catches were higher, was effective. No larvae were detected in the Eureka and Murcott trials, while three out of 5113 field fruit and one out of 5653 packed fruit were found to be infested during the Imperial trial.

Citrus from the Central Burnett district traded under ICA-28 was also subject to inspection by Victorian authorities for three seasons after it commenced. No fruit fly larvae were detected in random sampling of approximately 6000 tonnes of citrus at a rate of 100 fruit per consignment over the sampling program (QHI 2001). Queensland authorities further advise that since inception, and with 11 businesses currently accredited under ICA-28 across both production areas, no critical non-conformance incidents leading to trade in infested fruit have occurred (C. Tree *pers comm.* July 2011).

Proposal for New Import Requirement

- Adopt the systems approach described in ICA-28 for pre-harvest bait spraying and inspection of citrus from both areas specified under that protocol.

Restricted Risk

The systems approach for citrus from certain areas of Queensland outlined above can be expected to reduce the likelihood of Queensland fruit fly entry in that fruit from MODERATE to EXTREMELY LOW.

Unrestricted risk for Queensland fruit fly can therefore be expected to be reduced to VERY LOW, meaning Tasmania's ALOP is met.

3.5.9 SYSTEMS APPROACH – STRAWBERRIES FROM SOUTH EAST QUEENSLAND

Relevant Interstate Certification Assurance Protocol

ICA- (un-numbered) Pre-harvest field control and inspection of strawberries

This ICA describes a systems approach for mitigating risk of Queensland fruit fly and Lesser Queensland fruit fly (*Bactrocera neohumeralis*) in fresh strawberries from South East Queensland. The ICA protocol is limited to ground grown strawberries and takes effect between 1 June and 10 August.

The systems approach comprises pre-harvest measures including property plan development, pre-harvest bait spraying with Naturalure™ of fruit fly resting sites, use of Male Annihilation Technique (MAT) devices around the perimeter of growing blocks and field hygiene. Post harvest measures include identification and traceability arrangements, grading and packing conditions, packed product inspection requirements, and arrangements for non-conforming product.

The ICA protocol employs the winter window concept wherein fruit fly population pressure in strawberry production areas of South East Queensland is expected to be lower in the cool season. Nonetheless, as fly pressure may vary from cool season to cool season, pre and post-harvest measures described above are also applied to provide assurance that strawberries traded during that period are not infested with viable fruit fly larvae.

The ICA protocol has a precursor. Strawberries were previously exported from Queensland to Victoria and South Australia under a winter window arrangement extending from 1 June to 19 September, with no additional requirements. This period was based on the sampling work of Greer & Wait (1996) who concluded strawberries are a minor host in winter after finding very low rates of infestation from the start of winter until mid-September. However, trade was suspended by both importing States following the detection of Queensland fruit fly larvae in two consignments of strawberries harvested towards the end of that period, in late August-early September 2009.

Subsequently, further study intended to help Queensland growers regain market access occurred. Gu *et al.* (2010), who trapped commercial strawberry farms in South East Queensland in season 2008/2009, found male and female fruit flies numbers were very low between May and mid-August (Figures 5 and 6), with infestation rates rising thereafter. This was verified by inspection of strawberries harvested in this period, hence suggesting potential for a shorter winter window than that originally employed. Balagawi *et al.* (2010) demonstrated Queensland fruit fly distribution is greater on the edges of strawberry blocks in South East Queensland early in the production season, and concluded that Queensland fruit fly prefers to breed in border crops rather than strawberries at that time.

The first winter window experience led to the incorporation of the reduced winter window within the system of additional measures described in the ICA.

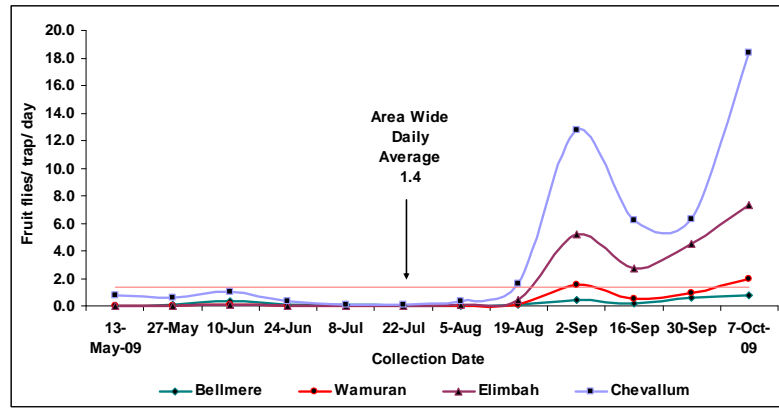


Figure 5 - Seasonal changes in trap catches of male fruit flies at four different strawberry farms in 2009 (from Gu *et al.* 2010)

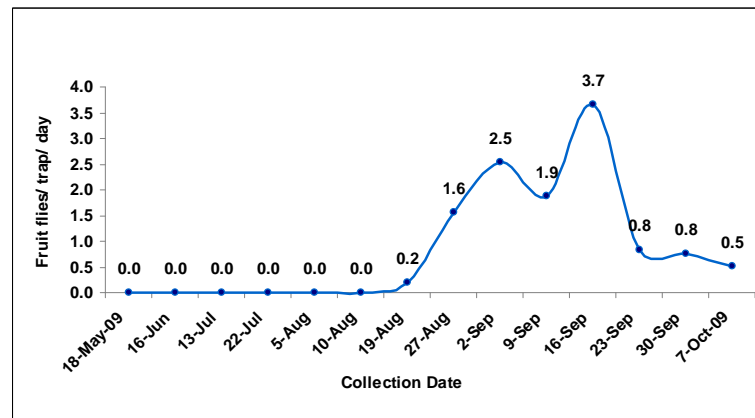


Figure 6 - Seasonal changes in trap catches of female fruit flies, averaged from three different strawberry farms in 2009 (from Gu *et al.* 2010)

Proposal for New Import Requirement

- Adopt the systems approach described in the ICA protocol for pre-harvest field control and inspection of strawberries.

Restricted Risk

The systems approach for strawberries from South East Queensland outlined above can be expected to reduce the likelihood of Queensland fruit fly entry in that fruit from MODERATE to EXTREMELY LOW.

Unrestricted risk for Queensland fruit fly can therefore be expected to be reduced to VERY LOW, meaning Tasmania’s ALOP is met.

PART FOUR: PROPOSED IMPORT REQUIREMENTS, MONITORING & VERIFICATION

4.1 PROPOSED IMPORT REQUIREMENTS

The proposed revised and new Import Requirements are presented below as they would appear in Tasmania's *Plant Quarantine Manual*. Import Requirement numbers will be allocated on publication of the manual.

SCHEDULES & NOTES: IMPORT REQUIREMENTS FOR FRUIT FLY HOST PRODUCE

*Import Requirements (note: IR numbers will be assigned on publication of the Plant Quarantine Manual 2011) apply to the importation of fruit that are hosts of Queensland Fruit Fly (*Bactrocera tryoni* (Froggatt)) and/or Mediterranean Fruit Fly (*Ceratitis capitata* (Wiedemann)). Main host fruit for each fly are listed in **Schedule 1A**. Unspecified fruit is regarded as susceptible to both flies unless an importer provides evidence to the contrary.*

*All host produce that is certified as meeting any Import Requirement for Queensland fruit fly and/or Mediterranean fruit fly must be handled, stored and transported under secure conditions in accord with **Schedule 1B**.*

The Import Requirements are equivalent options. Importers need only meet one Import Requirement.

Quarantine Tasmania and interstate quarantine authorities maintain the right to inspect certified produce at any time and to refuse to accept a certificate if produce does not conform to any Import Requirement.

Importers should note that the efficacy of any treatment specified in an Import Requirement is not guaranteed if applied to host fruit known to be infested with Queensland fruit fly or Mediterranean fruit fly. The DPIPWE accepts no liability for loss of product quality resulting from any treatment specified in an Import Requirement.

Schedule 1A: Fruit Fly Host fruit

Hosts of Queensland fruit fly and Mediterranean fruit fly include, but are not limited to:

HOST BOTANICAL NAME	HOST COMMON NAME	<i>B. tryoni</i> (QFF)	<i>C. capitata</i> (MFF)
<i>Acca sellowiana</i> (Myrtaceae)	Feijoa	QFF	MFF
<i>Actinidia deliciosa</i> (Actinidiaceae)	Kiwifruit	QFF	MFF
<i>Anacardium occidentale</i> (Anacardiaceae)	Cashew apple	QFF	MFF
<i>Annona cherimolia</i> (Annonaceae)	Cherimoya	QFF	MFF
<i>Annona glabra</i> (Annonaceae)	Pond apple		MFF
<i>Annona muricata</i> (Annonaceae)	Soursop	QFF	MFF
<i>Annona squamosa</i> (Annonaceae); <i>A. squamosa</i> x <i>A. cherimolia</i>	Custard apple	QFF	MFF
<i>Artocarpus altilis</i> (Moraceae)	Breadfruit	QFF	MFF
<i>Artocarpus heterophyllus</i> (Moraceae)	Jackfruit	QFF	MFF
<i>Averrhoa carambola</i> (Oxalidaceae)	Star fruit, Carambola	QFF	MFF
<i>Blighia sapida</i> (Sapindaceae)	Akee apple		MFF
<i>Capsicum annuum</i> (Solanaceae)	Capsicum, Bell pepper	QFF	MFF
<i>Capsicum annuum</i> var <i>acuminatum</i> (Solanaceae)	Chilli (<i>see also</i> Cherry pepper, and Tabasco)	QFF	MFF
<i>Capsicum annuum</i> var <i>cerasiforme</i> (Solanaceae)	Cherry pepper	QFF	MFF
<i>Capsicum annuum</i> var <i>conoides</i> (Solanaceae)	Tabasco	QFF	MFF
<i>Carica papaya</i> (Caricaceae)	Papaya, Paw Paw, Papaw	QFF	MFF
<i>Carica pentagona</i> (Caricaceae)	Babaco (ripe)	QFF	MFF
<i>Carissa macrocarpa</i> (Apocynaceae)	Natal Plum		MFF
<i>Casimiroa edulis</i> (Rutaceae)	White sapote	QFF	MFF
<i>Chrysophyllum cainito</i> (Sapotaceae)	Star apple, Caimito	QFF	
<i>Citrus aurantiifolia</i> (Rutaceae) (West Indian lime)	Lime (<i>see also</i> Rangpur lime)	QFF	MFF
<i>Citrus aurantium</i> (Rutaceae)	Seville orange	QFF	MFF
<i>Citrus grandis</i> (= <i>maxima</i>) (Rutaceae)	Pummelo	QFF	MFF
<i>Citrus latifolia</i> (Rutaceae)	Tahitian lime ¹²	QFF	MFF
<i>Citrus limon</i> (Rutaceae); <i>Citrus limon</i> x <i>C. chinense</i>	Lemon (<i>see also</i> Meyer lemon)	QFF	MFF
<i>Citrus medica</i> (Rutaceae)	Citron, Tangor	QFF	MFF
<i>Citrus meyeri</i> (Rutaceae)	Meyer Lemon	QFF	MFF
<i>Citrus paradisi</i> (Rutaceae)	Grapefruit	QFF	MFF
<i>Citrus reticulata</i> (Rutaceae)	Mandarin, Tangelo, Tangerine	QFF	MFF
<i>Citrus reticulata</i> var. <i>austera</i> (Rutaceae)	Rangpur lime	QFF	MFF
<i>Citrus sinensis</i> (Rutaceae)	Sweet orange	QFF	MFF

¹² Australian native 'finger lime' (*Microcitrus australasica*) is not a host of fruit fly, and should not be confused with Tahitian Lime, *Citrus latifolia*, which is a host of fruit fly

HOST BOTANICAL NAME	HOST COMMON NAME	<i>B. tryoni</i> (QFF)	<i>C. capitata</i> (MFF)
<i>Citrus x tangelo</i> (syn. <i>C. reticulata</i> x <i>C. paradisi</i>) (Rutaceae)	Tangelo	QFF	MFF
<i>Coffea arabica</i> (Arabian coffee) (Rubiaceae)	Coffee cherry (see also Excelsa, Liberian and Robusta coffee)	QFF	MFF
<i>Coffea canephora</i> (Rubiaceae)	Coffee cherry		MFF
<i>Coffea excelsa</i> (Rubiaceae)	Excelsa coffee		MFF
<i>Coffea liberica</i> (Rubiaceae)	Liberian coffee		MFF
<i>Coffea robusta</i> (Rubiaceae)	Robusta coffee		MFF
<i>Crataegus</i> spp. (Rosaceae)	Hawthorn		MFF
<i>Cydonia oblonga</i> (Rosaceae)	Quince	QFF	MFF
<i>Cyphomandra betacea</i> (Solanaceae)	Tamarillo, Tree tomato	QFF	MFF
<i>Diospyros decandra</i> (Ebenaceae)	Persimmon (see also Japanese persimmon)	QFF	MFF
<i>Diospyros ebenum</i> (Ebenaceae)	Black sapote	QFF	MFF
<i>Diospyros kaki</i> (Ebenaceae)	Japanese persimmon	QFF	MFF
<i>Durio zibethinus</i> (Bombacaceae)	Durian	QFF	MFF
<i>Eriobotrya japonica</i> (Rosaceae)	Loquat	QFF	MFF
<i>Eugenia brasiliensis</i> (Myrtaceae)	Grumichama	QFF	MFF
<i>Eugenia uniflora</i> (Myrtaceae)	Surinam cherry		MFF
<i>Euphoria longan</i> (Sapindaceae)	Longan	QFF	MFF
<i>Ficus carica</i> (Moraceae)	Fig	QFF	MFF
<i>Fortunella crassifolia</i> (Rutaceae)	Meiwa kumquat	QFF	
<i>Fortunella japonica</i> (Rutaceae)	Kumquat	QFF	MFF
<i>Fortunella margarita</i> (Rutaceae)	Kumquat	QFF	MFF
<i>Fragaria x ananassa</i> (Rosaceae)	Strawberry	QFF	MFF
<i>Garcinia mangostana</i> (Clusiaceae)	Mangosteen	QFF	MFF
<i>Juglans regia</i> (Juglandaceae)	Walnut (green walnut fruit only)		MFF
<i>Litchi chinensis</i> (Sapindaceae)	Lychee	QFF	MFF
<i>Lycopersicon esculentum</i> (syn. <i>Lycopersicon lycopersicum</i>) (Solanaceae)	Tomato Note: Pink and red types only	QFF	MFF
<i>Malpighia glabra</i> (syn. <i>M. puniceifolia</i>) (Malpighiaceae)	Acerola	QFF	MFF
<i>Malus domestica</i> (Rosaceae)	Apple	QFF	MFF
<i>Malus sylvestris</i> (Rosaceae)	Crab apple	QFF	MFF
<i>Mangifera indica</i> (Anacardiaceae)	Mango	QFF	MFF
<i>Manilkara zapota</i> (Sapotaceae)	Sapodilla	QFF	MFF
<i>Mimusops elengi</i> (Sapotaceae)	Spanish cherry, Red coondoo		MFF
<i>Monstera deliciosa</i> (Araceae)	Monstera		MFF
<i>Morus nigra</i> (Moraceae)	Mulberry	QFF	MFF
<i>Murraya exotica</i> (Rutaceae)	Mock orange		MFF

HOST BOTANICAL NAME	HOST COMMON NAME	<i>B. tryoni</i> (QFF)	<i>C. capitata</i> (MFF)
<i>Musa</i> spp. (Musaceae)	Banana, Plantation banana	QFF	MFF
<i>Myrciaria cauliflora</i> (Myrtaceae)	Jaboticaba	QFF	MFF
<i>Nephelium lappaceum</i> (Sapindaceae)	Rambutan	QFF	MFF
<i>Noronhia emarginata</i> (Oleaceae)	Madagascar olive		MFF
<i>Ochrosia elliptica</i> (Apocynaceae)	Bourbon orange		MFF
<i>Olea europaea</i> (Oleaceae)	Olive (<i>see also</i> Madagascar olive)		MFF
<i>Opuntia ficus-indica</i> (Cactaceae)	Prickly pear	QFF	MFF
<i>Opuntia stricta</i> (Cactaceae)	Prickly pear	QFF	MFF
<i>Passiflora edulis</i> f. <i>edulis</i> (Passifloraceae) (Purple passionfruit) <i>Passiflora edulis</i> f. <i>flavicarpa</i> (Yellow passionfruit)	Passionfruit	QFF	MFF
<i>Passiflora quadrangularis</i> (Passifloraceae)	Granadilla	QFF	MFF
<i>Persea americana</i> (Lauraceae)	Avocado	QFF	MFF
<i>Phoenix dactylifera</i> (Arecaceae)	Date	QFF	MFF
<i>Physalis peruviana</i> (Solanaceae)	Cape gooseberry	QFF	MFF
<i>Pouteria caimito</i> (Sapotaceae)	Abiu	QFF	MFF
<i>Pouteria sapota</i> (Sapotaceae)	Mamey sapote		MFF
<i>Prunus amygdalus</i> (<i>P. dulcis</i>) (Rosaceae)	Almond (with husk)		MFF
<i>Prunus armeniaca</i> (Rosaceae)	Apricot	QFF	MFF
<i>Prunus avium</i> (Rosaceae)	Sweet cherry	QFF	MFF
<i>Prunus cerasus</i> (Rosaceae)	Sour cherry	QFF	MFF
<i>Prunus domestica</i> (Rosaceae)	Plum (<i>see also</i> Damson, and Japanese plum)	QFF	MFF
<i>Prunus domestica</i> x <i>P. armeniaca</i>	Plumcot	QFF	MFF
<i>Prunus insitita</i> (Rosaceae)	Damson plum	QFF	
<i>Prunus persica</i> (Rosaceae)	Peach	QFF	MFF
<i>Prunus persica</i> var. <i>nectarina</i> (Rosaceae)	Nectarine	QFF	MFF
<i>Prunus persica</i> var. <i>nucipersica</i> . (Rosaceae)	Peacharine	QFF	MFF
<i>Prunus salicina</i> (Rosaceae)	Japanese plum	QFF	
<i>Psidium cattleianum</i> var. <i>guineense</i> (Myrtaceae)	Brazilian guava	QFF	MFF
<i>Psidium cattleianum</i> var. <i>lucidum</i> (Myrtaceae)	Yellow cattley guava	QFF	MFF
<i>Psidium friedrichsthalianum</i> (Myrtaceae)	Costa Rican guava	QFF	MFF
<i>Psidium guajava</i> (Myrtaceae)	Guava (<i>see also</i> Brazilian, Costa Rican, strawberry, and yellow cattley guava)	QFF	MFF
<i>Psidium littorale</i> (syn. <i>P. cattleianum</i>) (Myrtaceae)	Strawberry guava	QFF	MFF
<i>Punica granatum</i> (Punicaceae)	Pomegranate	QFF	MFF
<i>Pyrus betulaeifolia</i> (Rosaceae)	Nashi	QFF	MFF
<i>Pyrus communis</i> (Rosaceae)	Pear	QFF	MFF

HOST BOTANICAL NAME	HOST COMMON NAME	<i>B. tryoni</i> (QFF)	<i>C. capitata</i> (MFF)
<i>Pyrus pyrifolia</i> (Rosaceae)	Nashi pear	QFF	MFF
<i>Rollinia deliciosa</i> (Annonaceae)	Rollinia	QFF	MFF
<i>Rollinia mucosa</i> (Annonaceae)	Rollinia	QFF	MFF
<i>Rubus fruticosus</i> (Rosaceae)	Blackberry	QFF	MFF
<i>Rubus idaeus</i> (Rosaceae)	Raspberry	QFF	MFF
<i>Rubus loganobaccus</i> (Rosaceae)	Loganberry	QFF	MFF
<i>Rubus ursinus</i> var. <i>loganobaccus</i>	Boysenberry	QFF	MFF
<i>Rubus ursinus</i> x <i>R. loganobaccus</i>	Youngberry	QFF	
<i>Sandoricum indicum</i> (Meliaceae)	Santol	QFF	
<i>Sideroxylon inerme</i> (Sapotaceae)	Ironwood		MFF
<i>Solanum lycopersicum</i> (Solanaceae)	Tomato	QFF	MFF
<i>Solanum melongena</i> (Solanaceae)	Eggplant	QFF	MFF
<i>Solanum muricatum</i> (Solanaceae)	Pepino	QFF	MFF
<i>Solanum pseudocapsicum</i> (Solanaceae)	Jerusalem cherry		MFF
<i>Spondias cytherea</i> (Anacardiaceae)	Jew plum		MFF
<i>Spondias</i> spp. (Anacardiaceae)	Mombin	QFF	MFF
<i>Syzygium cumini</i> (Myrtaceae)	Jambu		MFF
<i>Syzygium jambos</i> (syn. <i>Eugenia jambos</i>) (Myrtaceae)	Rose apple	QFF	MFF
<i>Syzygium malaccense</i> (syn. <i>Eugenia malaccensis</i>) (Myrtaceae)	Mountain apple (note the term 'rose apple' is commonly used for two different species of <i>Syzygium</i>)		MFF
<i>Syzygium samarangense</i> (Myrtaceae)	Wax apple		MFF
<i>Syzygium</i> spp. (Myrtaceae)	Lilly pilly		MFF
<i>Terminalia catappa</i> (Combretaceae)	Tropical almond		MFF
<i>Terminalia chebula</i> (Combretaceae)	Chebolic myrobalan		MFF
<i>Vaccinium corymbosum</i> , <i>V. ashei</i> (Ericaceae)	Blueberry	QFF	MFF
<i>Vitis labrusca</i> (Vitaceae)	Isabella grape, Fox grape	QFF	MFF
<i>Vitis vinifera</i> (Vitaceae) (table grape)	Grape (table)	QFF	MFF
<i>Vitis vinifera</i> L. [Vitaceae] (wine grape)	Grape (wine) (<i>see also</i> Isabella grape)	QFF	MFF
<i>Wikstroemia phillyreifolia</i> (Thymelaeaceae)	Akia		MFF
<i>Ziziphus jujube</i> (Rhamnaceae)	Jujube, Chinese date	QFF	MFF

Schedule 1B

Produce certified under any Import Requirement for Queensland fruit fly or Mediterranean fruit fly must be handled, stored and transported in secure conditions. Secure conditions are:

- (a) unvented packages;
- (b) vented packages with the vents secured with mesh with a maximum aperture of 1.6mm;
- (c) shrink-wrapped and sealed palletised units;
- (d) fully enclosed or screened buildings, cold rooms, vehicles or other facilities free from gaps or other entry points greater than 1.6mm.

Import Requirement X: Fruit Fly Host Produce – Area Freedom

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of a plant listed in Schedule 1A except in accordance with the following:
 - (a) The fruit was grown in an area of the Australian mainland maintained as fruit fly free¹; and
 - (b) The fruit was grown more than 7.5km or 15km from the discovery point or epicentre of any outbreak of Mediterranean fruit fly, whichever is applicable²; and
 - (c) The fruit was grown more than 15km or 30km from the discovery point or epicentre of any Queensland fruit fly outbreak, whichever is applicable²; or
 - (d) If the trapping rate for Queensland fruit fly exceeds 35 male flies within two weeks in permanent plus 16 supplementary Lynfield male-lure traps deployed within 200m of an discovery point or outbreak epicentre, the fruit was grown more than 80km from that outbreak discovery point or epicentre; and
- II. If the fruit meets I(a) but does not meet I(b), I(c) and I(d), it must have been harvested not less than one generation³ and twenty-eight days after the last fly was detected in traps or in fruit in the outbreak area.

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate

Explanatory notes:

¹*Denotes any area on the Australian mainland managed in accord with the Codes of Practice for the Management of Queensland Fruit Fly and Mediterranean Fruit Fly (CoPs), or any subsequent version/s endorsed by Plant Health Committee.*

²*Denotes trade suspension zone radii around fruit fly outbreaks that take effect under the CoPs. The smaller radius applies in the event outbreak flies are detected within 1km of each other within two weeks. The larger radius applies when outbreak flies are detected more than 1km apart within two weeks.*

³*Generation time is as calculated under the CoPs*

Import Requirement X Fruit Fly Host Produce – Disinfestation with Methyl Bromide

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of a plant listed in Schedule 1A unless: it has been fumigated with methyl bromide for two hours at one of the following rates:

Methyl Bromide (g/m ³)	Flesh Temperature (°C)
32	21+
40	16-20.9
48	11-15.9
56	10-10.9

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory notes:

This Import Requirement applies in respect of Queensland fruit fly and Mediterranean fruit fly.

All methyl bromide fumigation must be carried out by a licensed fumigator in an approved chamber.

Treated fruit may be allowed to air adequately for the minimum practical period after fumigation prior to securing as per Schedule 1B.

Consignments that meet Interstate Certification Assurance (ICA) protocol ICA-04 (Fumigating with methyl bromide) satisfy this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Disinfestation by Cold Storage

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of a plant listed in Schedule 1A, unless it has been cold treated according to the following:

Fruit core temperature at treatment start	Treatment duration (days)
Queensland Fruit Fly.	
0°C ± 0.5 °C	14
1.0°C ± 0.5 °C	16 (lemons 14)
2.0°C ± 0.5 °C	16 (lemons 14)
3.0°C ± 0.5 °C	16 (lemons 14)
Mediterranean Fruit Fly.	
0°C ± 0.5 °C	14
1°C ± 0.5 °C	16 (lemons 14)
2°C ± 0.5 °C	18 (lemons 16)
3°C ± 0.5 °C	20 (lemons 18)

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory note:

Consignments that meet Interstate Certification Assurance (ICA) protocol ICA-07 (cold treatment) satisfy this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Disinfestation of Mango and Papaya with Heat

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of the species *Mangifera indica* (mango) or *Carica papaya* (papaya/papaw/pawpaw), unless it has been treated according to the following as relevant.
 - (a) Mango must be treated:
 - i. under AQIS supervision in an approved vapour heat treatment facility at 47°C for a minimum period of 15 minutes; or
 - ii. by immersion in hot water at an approved facility such that the temperature of the flesh adjacent to the seed is at 46°C for at least 20 minutes.
 - (b) Papaya/papaw/pawpaw must be treated in an approved high temperature forced air chamber for at least 3.5 hours and until the seed cavity in the heaviest fruit in each batch reaches a temperature of 47.2°C. The flesh of the fruit must be firm and not distort when packed into the chamber.

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory notes:

An Approved Vapour Heat Treatment Facility means a facility that has:

- a) current registration as a Registered Export Establishment (REE) under the Commonwealth Export Control Act 1982; and*
- b) current approval from AQIS for vapour heat treatment of mangoes for export.*

Part I (a) of this Import Requirement applies in respect of Queensland fruit fly only

Part I (b) of this Import Requirement applies in respect of Queensland fruit fly and Mediterranean fruit fly

Consignments of mangoes that meet Interstate Certification Assurance (ICA) protocol ICA-05 (Vapour heat treatment of mangoes under AQIS supervision) satisfy part I (a) i of this Import Requirement. Consignments of mangoes that meet ICA-10 (Hot water treatment of mangoes) do not satisfy part I (a) ii of this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Hard Green or Similar Condition

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of a plant listed below unless it has unbroken skin and complies with the following:
- (a) **Avocados** (Hass, Sharwill, Fuerte and Reed cultivars) - must have been harvested in a hard condition;
 - (b) **Bananas** (all varieties) - must be mature and green. Mature means the flesh is hard and not flexible. Green means the skin is green and shows no yellow colouration except for areas towards the flower end provided the flesh beneath is still hard;
 - (c) **Black Sapote** – must be green with skin free of black colouring;
 - (d) **Durians, Jackfruit, Longans, Lychees, Mangosteens, Rambutans, Jabotica and Pomegranate** – must be firm fleshed;
 - (e) **Passionfruit** (purple types only) – must be unwrinkled;
 - (f) **Papayas** (non-defective flowering type only) **and Babaco** – must be hard and green. Hard means fruit is not soft or softening on any part. Green means the skin is green and shows no more than 25% of its ripening colour over its whole surface;
 - (g) **Tahitian limes** – must be mature and green. Mature means the flesh is hard. Green means the skin is green and shows no yellow colouration;
 - (h) **Tomatoes** – must be mature and green. Mature and green means fruit has no more than a two centimetre diameter area of pink to red colour at the stylar end at the time of sorting after harvest

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate

Explanatory notes:

Unbroken skin means the skin has no pre-harvest cracks, punctures, pulled stem or other breaks that penetrate to the flesh, including breaks that have healed with callus tissue.

Part I (a) of this Import Requirement applies in respect of Mediterranean fruit fly only

Part I (b) of this Import Requirement applies in respect of Queensland fruit fly and Mediterranean fruit fly

Parts I (c) – I (h) of this Import Requirement apply in respect of Queensland fruit fly only

Consignments of any of the above fruit that meet Interstate Certification Assurance (ICA) protocols ICA 06 (Certification of hard green bananas), ICA 08 (Mature green condition and immature green condition of papaw and babaco), ICA 13 (Unbroken skin condition of approved fruits), ICA 15 (Mature green condition of passionfruit, Tahitian limes and black sapotes), ICA 16 (Certification of mature green condition of bananas), ICA-27 (Mature green condition of tomatoes) and ICA 30 (Hard condition of avocados for Mediterranean fruit fly) , as relevant, satisfy this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Irradiation

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, any fruit of a plant listed in Schedule 1A unless it has been:
 - (a) approved for irradiation by Food Standards Australia and New Zealand; and
 - (b) irradiated by a business approved to do so to a minimum absorbed dose of 150 Gy.

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory note:

This Import Requirement applies in respect of Queensland fruit fly and Mediterranean fruit fly

A business approved to irradiate fruit fly host produce is any business accredited under Interstate Certification Assurance (ICA) protocol ICA-55 (Irradiation Treatment). Consignments that meet ICA-55 satisfy this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Systems approach for citrus

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- I. A person must not import, or cause to be imported, fruit of any cultivar of mandarin, tangor, orange, lime, grapefruit or lemon unless that fruit has been grown and packed in accord with an approved systems approach.

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory notes:

This Import Requirement applies in respect of Queensland fruit fly only

Meyer lemons are not covered by this Import Requirement. An alternative import option must be met.

An approved systems approach is that described in the Interstate Certification Assurance (ICA) protocol ICA-28 (Pre-harvest Bait Spraying and Inspection of Citrus). Consignments of citrus that meet ICA-28 satisfy this Import Requirement.

Import Requirement X: Fruit Fly Host Produce – Systems approach for strawberries

Prior to import, a “Notice of Intention to Import Produce into Tasmania” must be received by the relevant Quarantine Centre. Importation must occur in compliance with all general Conditions and Restrictions for Prescribed Matter in Part 2 of this Manual.

- II. A person must not import, or cause to be imported, any strawberry fruit unless that fruit has been grown and packed in accord with an approved systems approach.

PROOF: Consignments must be accompanied by a Plant Health Certificate or a Plant Health Assurance Certificate.

Explanatory notes:

This Import Requirement applies in respect of Queensland fruit fly only

An approved systems approach is that described in the Interstate Certification Assurance (ICA) protocol ICA-XX (Pre-harvest Field Control and Inspection of Strawberries). Consignments of strawberries that meet ICA-XX satisfy this Import Requirement.

4.2 MONITORING OF PROPOSED IMPORT REQUIREMENTS

The pest risk estimates made in this review, and recommendations for risk mitigation are anticipated to remain reliable for at least the next five years, after which the next review should be initiated. However, since pest risk levels change and risk estimates inherently involve uncertainty, monitoring and verification of the effectiveness of the proposed import requirements in the interim, should they be accepted for implementation, is prudent.

One area of uncertainty in this review concerns potential for fruit fly establishment in Tasmania. Although, the DPIPWE modelling confirms previous work that suggests Tasmanian conditions are marginal for Queensland fruit fly, the potential magnitude of impact implies more structured monitoring for changes in the southern Australian distribution of this species is worthwhile. Such a monitoring strategy, which should also apply to Mediterranean fruit fly and other pest fruit fly species listed in the pest categorisation section of this review, could include annual compilation of information on:

- Current distribution of each species, including outbreak frequency and outbreaks in new locations;
- Use or trialling of new lure or other detection technology;
- Results of any new distribution or outbreak modelling;
- Any other mainland fruit fly monitoring and outbreak information, as relevant.

Annual distribution monitoring reports would collectively inform review of the fruit fly Import Requirements in 2016.

Another area of uncertainty is treatment efficacy, particularly in relation to additional systems approaches that are expected to be developed to minimise impacts of likely restrictions on the use of dimethoate and fenthion. All jurisdictions have an interest in this and hence Tasmania can participate in and benefit from national initiatives to verify treatment efficacy. Towards this, a treatment verification strategy could include compilation of information on:

- Results of on-arrival inspection at the current rate of 600 pieces per consignment;
- Type of phytosanitary condition under which host produce was imported;
- Volume and type of host produce and significant changes in either compared with the previous year;
- Mode of certification (business or government).

Annual inspection reports would collectively inform review of the fruit fly Import Requirements in 2016. Detections could also trigger earlier review, depending on whether these indicated treatment failures.

APPENDIX 1: RELEVANT STANDARDS

INTERNATIONAL STANDARDS

International Standards for Phytosanitary Measures (ISPMs) relevant to fruit flies are listed below and available at www.ippc.int:

ISPM No. 1: *Principles of plant quarantine as related to international trade*, 1995. FAO, Rome.

ISPM No. 2: *Guidelines for pest risk analysis*, 1996. FAO, Rome.

ISPM No. 4: *Requirements for the establishment of pest free areas*, 1996. FAO, Rome.

ISPM No. 5: *Glossary of phytosanitary terms*, 2004. FAO, Rome.

Glossary Supplement No. 1: *Guidelines on the interpretation and application of the concept of official control for regulated pests*, 2001. FAO, Rome.

Glossary Supplement No. 2: *Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations*, 2003. FAO, Rome

ISPM No. 8: *Determination of pest status in an area*, 1998. FAO, Rome.

ISPM No. 9: *Guidelines for pest eradication programmes*, 1998. FAO, Rome.

ISPM No. 10: *Requirements for the establishment of pest free places of production and pest free production sites*, 1999. FAO, Rome.

ISPM No. 11: *Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms*, 2004. FAO, Rome.

ISPM No. 14: *The use of integrated measures in a systems approach for pest risk management*, 2002. FAO, Rome.

ISPM No. 18: *Guidelines for the use of irradiation as a phytosanitary measure*, FAO, 2003, Rome

ISPM No. 22: *Requirements for the establishment of areas of low pest prevalence*, 2005, FAO, Rome.

ISPM No. 26: *Establishment of Pest Free Areas for Fruit Flies (TEPHRITIDAE)*.

ISPM No. 29 *Recognition of pest free areas and areas of low pest prevalence*.

ISPM No. 30 *Establishment of areas of low pest prevalence for fruit flies (Tephritidae)* (FAO, 2008).

Requirements for the Establishment and Maintenance of Pest Free Areas for Tephritid Fruit Flies. (APPPC, 2005b).

Guidelines for the Development of Heat Disinfestation Treatments of Fruit Fly Host Commodities. (APPPC, 2005a).

Guidelines for the Confirmation of Non-Host Status of Fruit and Vegetables to Tephritid Fruit Flies. (APPPC, 2005a).

Guidance for packing, shipping holding and release of sterile flies in area-wide fruit fly control programmes. (FAO, 2007).

DOMESTIC STANDARDS

National Code of Practice for the Management of Queensland Fruit Fly

Draft National Code of Practice for the Management of Mediterranean Fruit Fly

Interstate Certification Assurance (ICA) Protocols: The ICAs relevant to fruit flies are listed below and are available from www.dqmwg.org.au/go/dqmwg/ica-database.

- ICA-01: Dipping with Dimethoate or Fenthion
- ICA-02: Flood Spraying with Dimethoate or Fenthion
- ICA-03: Low Volume Non-Recirculated Spraying with Fenthion
- ICA-04: Fumigating with Methyl Bromide
- ICA-05: Vapour Heat Treatment of Mangoes Under AQIS Supervision
- ICA-06: Certification of Hard Green Condition of Bananas
- ICA-07: Cold Treatment
- ICA-08: Mature Green Condition and Immature Green Condition of Papaw and Babaco
- ICA-10: Hot Water Treatment of Mangoes
- ICA-11: Pre-Harvest Treatment and Inspection of Strawberries
- ICA-13: Unbroken Skin Condition of Approved Fruits
- ICA-14: Pre-Harvest Treatment and Inspection of Lychees
- ICA-15: Mature Green Condition of Passionfruit, Tahitian Limes and Black Sapotes
- ICA-16: Certification of Mature Green Condition of Bananas
- ICA-17: Splitting Consignments and Reconsigning Original Consignments of Certified Produce
- ICA-18: Treatment and Inspection of Custard Apple and Other Annona spp.
- ICA-19: Treatment and Inspection of Mangoes
- ICA-20: Pre-harvest Treatment and Inspection of Grapes
- ICA-21: Pre-harvest Treatment and Inspection of Stonefruit
- ICA-23: Certification of Area or Property Freedom based on monitoring by an accredited authority
- ICA-26: Pre-Harvest Treatment for Tomatoes, Capsicums, Chillies and eggplant
- ICA-27: Mature Green Condition of Tomatoes
- ICA-28: Pre-harvest Treatment (Bait Spraying) and Inspection of Citrus
- ICA-30: Hard Condition of Avocado for Mediterranean Fruit Fly
- ICA-31: Pre-harvest Insecticide Treatment of Blueberries
- ICA-55: Irradiation Treatment
- ICA-XX Pre-harvest field control and inspection for strawberries

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