EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION

ORGANISATION EUROPEENNE ET MEDITERRANEENNE

POUR LA PROTECTION DES PLANTES

11-17189
Final for the Web

PEST RISK ANALYSIS FOR : *Drosophila suzukii*

Pest risk analysis prepared by an Expert Working Group for performing PRA 2010-07-05/08

Expert Working Group composition

BAKER Richard (Mr)	Food and Environment Research Agency, York (GB) richard.baker@fera.gsi.gov.uk
BAUFELD Peter (Mr)	Julius Kühn-Institut (JKI), Kleinmachnow (DE) peter.baufeld@jki.bund.de
GRASSI Alberto (Mr)	Fondazione Edmund Mach – IASMA, S.Michele all'Adige (IT) alberto.grassi@iasma.it
GUITIAN CASTRILLON Jose Maria (Mr)	Tecnologias y Servicios Agrarios, S. A. - TRAGSATEC, Madrid (ES) jmgc@tragsa.es
HAUSER Martin (Mr)	California Department of Food and Agriculture, Sacramento (USA) MHauser@cdfa.ca.gov
HUEPPELSHEUSER Tracy (Ms)	British Columbia Ministry of Agriculture and Lands, Abbotsford (CA) tracy.hueppelsheuser@gov.bc.ca
KNIGHT Jonathan (Mr)	Imperial College London, (United Kingdom) j.d.knight@imperial.ac.u
REYNAUD Philippe (Mr)	Laboratoire National de Protection des Végétaux, Angers (FR) philippe.reynaud@agriculture.gouv.fr
OEPP/EPPO	PETTER Françoise (Ms), Paris (FR) fp@eppo.fr
	SUNLEY Robert (Mr) Paris (FR) robert.sunley@eppo.fr

Stage 1: Initiation

1 - Reason for performing the PRA

In November 2009, Italy notified the occurrence of *D. suzukii* in the Trentino-Alto-Adige region. In El Perelló, Spain (150 km from Barcelona, Catalonia) the insect has been detected in traps since October 2008. In France *D. suzukii* was collected in traps and identified in both Montpellier and Minière de Vallauria in 2009. It was subsequently officially identified in June 2010 on cherry, peach and apricot in Corsica, and on strawberry in the Alpes Maritimes.

In the USA and Canada this species is an important pest which has spread very fast through the fruit and wine growing areas. This pest has a very high reproduction potential and poses a serious threat to soft skinned fruit.

In Canada *D. suzukii* is not regulated as a pest but a recent pest categorization has determined that it meets the official definition of a quarantine pest by IPPC criteria (Damus, 2010). It has also been declared a quarantine pest by New Zealand (MAF, 2009), and the pest also came under Australian regulation (Public Quarantine Alert PQA0665, effective from 18 May 2010).

2a - Name of the pest

Drosophila suzukii (Matsumura)

Preferred scientific name: *Drosophila suzukii* (Matsumura, 1931)
Synonym: *Leucophenga suzukii* (Matsumura, 1931)
EPPO Code: DROSSU
Common names: Cherry vinegar fly, Spotted wing drosophila, cherry fruit fly, cherry drosophila, drosophile du cerisier (French), Kirschessigfliege (German), yīng táo gǔo yíng (Chinese), ôtô-syôzyôbae, ôtô-shôjôbae, Suzuki-shôjôbae, Tsumaguro-shôjôbae (Japanese)

2b - Type of the pest

Arthropod

2d - Taxonomic position

Arthropoda, Insecta, Diptera, Drosophilidae, Drosophila suzukii

3 - PRA area

EPPO region

Earlier analysis

The pest, or a very similar pest, may have been subjected to the PRA process before, nationally or internationally. This may partly or entirely replace the need for a new PRA.

4 - Relevant earlier PRA exist?

Two PRAs have been prepared on this pest:

- Damus, M. 2009. Plant Health Risk Assessment: *Drosophila suzukii* (Matsumura), Spotted wing drosophila. Unpublished, Canadian Food Inspection Agency, 2009.
- Biosecurity Australia, 2010. Draft pest risk analysis report for *Drosophila suzukii*

5 - Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?

The two PRAs are recent and include information relevant for the EPPO PRA but they are focused on risks for Canada or Australia so they are not entirely valid.

6 - Host plant species (for pests directly affecting plants).

D. suzukii infests both cultivated and wild hosts.

Crops on which significant economic damage has been reported are:

Fragaria anannassa (strawberries), *P. armeniaca* (apricots), *Prunus avium* (sweet cherries), *P. persica* (peaches), *Rubus armeniacus* (Himalayan blackberries), *R. loganobaccus* (loganberries), *R. idaeus* (raspberries), *R. laciniatus* (evergreen blackberries), *R. ursinus* (marionberries), and other blackberries (*Rubus* spp.), *Vaccinium* spp. (blueberries).

Crop on which damage has been reported in the past, but no recent publications confirm it.
Vitis vinifera (table and wine grapes).
Damage on *Vitis vinifera* (table and wine grapes) has been recorded in Japan (Kansawa, 1939). Contacts were made with Dr Kimura from the zoological institute of the Hokkaido University. He confirmed that there are some reports of damages on grapes in Japan, but no details have been provided. In Oregon, the pest emerged from wine grapes but no noticeable damage had been noted (Herring, 2009). In California, the pest is present in cherry orchards in the vicinity of vineyards, and no damage has been recorded in these vineyards so far (Hauser, pers. comm. 2010). In Washington state Malguashca *et al.* (2010) report that field cage tests were conducted with Syrah grapes. In September 2010 adults were released into each cage. No *D. suzukii* were observed in any grapes exposed to the pest in the vineyard in these studies.
Dr Kimura (*pers. comm.* 2010) explained that he once tried to rear *D. suzukii* on grapes, and observed that it could not penetrate grape's skin with its ovipositor, since grape skin is rather thick and tough. He observed that oviposition occurred on injured grapes but commented that it cannot be excluded that *D. suzukii* may be able to insert its ovipositor in grape varieties with thin skin. The observation by Dr Kimura that oviposition occurs in injured grape is consistent with other observations made in USA; in particular Malguashca *et al.* (2010) report that injury appears to be the greatest factor in determining if *D. suzukii* can oviposit successfully and maggots hatch out.
Finally the article of Malguashca *et al. (*2010) mentions that samples of grapes that exhibited a substantial number of splits due to recent rains were received in the Entomology laboratory (Prosser Washington State), and that maggots were observed in fruit that were split. The maggots were reared and identified as *Drosophila melanogaster*, a vinegar fly species that has been long established and present in Washington vineyards. Whether more damage can be expected from *D. suzukii* is not known.

From these different observations it is difficult to conclude whether grapes are host and there is uncertainty whether they can be considered as important as those for which significant damage is repeatedly reported.
Other recorded hosts include:
Actinidia arguata (hardy kiwis), *Cornus* spp., *Diospyros kaki* (persimmons), *Ficus carica* (figs),
D. suzukii can be present in already damaged fruits, e.g. *Malus domestica* (apples) and *Pyrus pyrifolia* (Asian pears).
D. suzukii was reared on *Lycopersicon esculentum* (tomato) in the laboratory but no natural infestation has been recorded. In France numerous flies have been trapped in Tomato crops (French NPPO, 2010-12) however no information on damage is available nor on the possible close vicinity of other hosts(further information has been requested by the EPPO Secretariat).

The list of hosts is presented in Appendix 1

7 - Specify the pest distribution

EPPO region:

- Russia (southern Siberia, Storozhenko *et al.*, 2003)
- Spain (detected in traps in El Perelló Catalonia, from 2008, EPPO 2010)
- Italy (Trentino-Alto-Adige region, EPPO 2010 a); Toscana region, EPPO 2010b); Piemonte (EPPO 2010d)
- France (Corsica, Languedoc Roussillon, Midi Pyrénées, Provence Alpes Côte d'Azur and Rhone Alpes, EPPO 2010b & 2010c).
- Slovenia (detected in traps, Benko, pers. comm. 2011)

Central America :

- Costa Rica (Ashburner *et al.* 2005)

North America:

- USA: California (2008), Oregon (2009), Washington (2009), Florida (2009), Louisiana (2010), North Carolina (2010), South Carolina (2010) and Utah (2010) [Hauser, pers. comm. 2010]
- Canada: British Columbia (in the Fraser River and Okanagan Valleys (Damus, 2010); Vancouver, in private Gardens [Damus, pers. comm. 2010])

South America :

- Ecuador (Ashburner *et al.* 2005)

Oceania:

- Hawaii (since at least 1980) (Kaneshiro 1983)

Asia:

The fly was first observed in Mainland (Honshu) Japan in 1916 (Kanzawa 1936).

- Japan (Amami, Hokkaido, Honshu, Kyushu, Shikoku, Okada 1964; Ryukyu)
- China (Guangxi, Guizhou, Henan, Hubei, Yunnan, Zhejiang) [Toda, 1991]
- India (Chandigarh, Jammu and Kashmir, Uttar Pradesh) [Singh & Negi, 1989]
- Thailand (Toda, 1991)
- Korea (Okada 1964)
- Burma (Damus 2010)

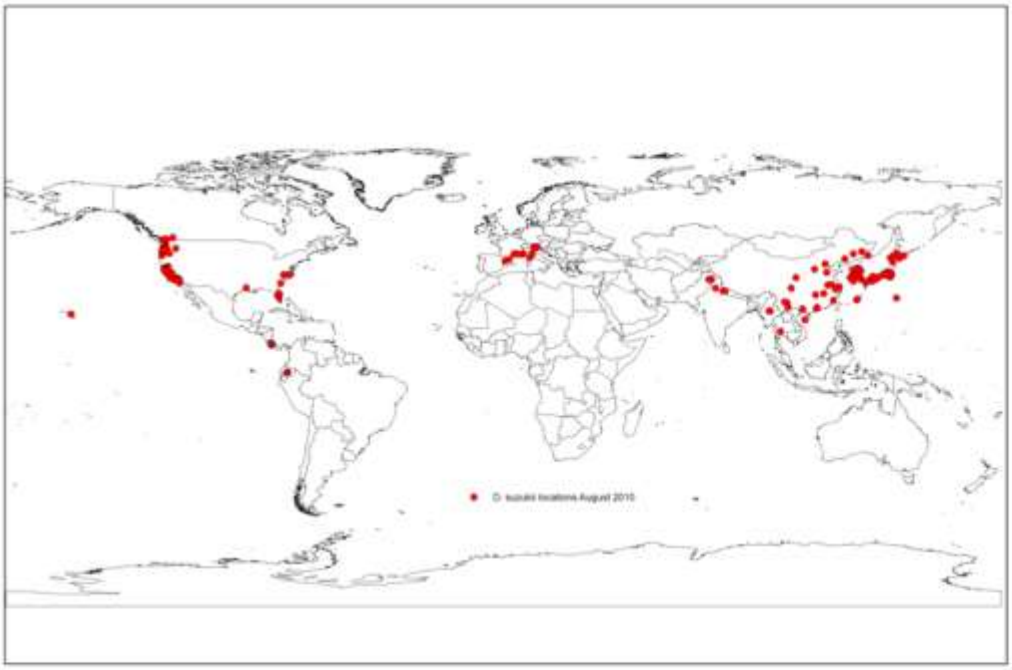


Fig 1 global distribution of Drosophila suzukii (2010-08)

Stage 2: Pest Risk Assessment - Section A : Pest categorization
Pest name : **Drosophila suzukii (Matsumura)**

8 - Does the name you have given for the organism correspond to a single taxonomic entity which can be adequately distinguished from other entities of the same rank?
It is a single taxonomic entity. See also question 2a.

10 - Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?
yes (the organism is considered to be a pest)
When *D. suzukii* occurs under appropriate climatic conditions, it causes significant crop damage. Records of crop damage in Japan exist from as early as 1935 (Kanzawa, 1935). In California where it has recently established, it has quickly spread and caused extensive crop damage (Bolda, 2009). Damage to fruit crops has also been recorded in France and Italy (EPPO 2009, EPPO 2010a). Symptoms have been observed on blackberry, blueberry, cherry, raspberry and strawberry. In some areas the pest has been trapped but no damage is reported so far (Spain, areas of France other than Provence Alpes Côte d'Azur and Corsica, and Piemonte Italy).

12 - Does the pest occur in the PRA area? yes
In the EPPO region the pest currently has a limited distribution. There have been detections of *D. suzukii* in Spain in traps (El Perello just north of the Ebro Delta, and some 133 km SW of Barcelona), France (Corsica, Languedoc Roussillon*, Midi Pyrénées*, Provence Alpes Côte d'Azur and Rhone Alpes*, EPPO 2010a & 2010b), Italy (province of Trento - Trentino-Alto Adige, Piemonte* and Toscana*), and Far East Russia (Far East).
*in traps only
13 - Is the pest widely distributed in the PRA area? not widely distributed see 12

14 - Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)? yes
In terms of important agricultural hosts, all the major hosts (see question 6 Table 1) are present in the EPPO region, several are planted extensively.

Table 1 Production figures for Europe, North Africa, West Asia (Source FAO Stat accessed 2010/07/02 detailed tables are presented in Appendix 2)

Fruit	Surface ha (2007)	Surface ha (2008)
Cherries	**265756**	**280447**
Strawberries	207760	195010
Raspberries	92784	82167
Blueberries	17365	17504
Current	139890	115548
Other berries	38632	38964
Peaches and nectarines	412533	468637
Apricot	282160	271968
Total potential hosts	1456880	1470245
Grapes	4996765	5040451
Total "potential hosts with grapes"	6453645	6510696
all fruits	12871995	12790219

This represents approximately 12% of the total area of fruit production (without grapes) but nearly 50% with grapes

15a - Is transmission by a vector the only means by which the pest can spread naturally? no

16 - Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)? yes
The fact that *D. suzukii* seems to favour cool and humid climate (e.g. in central coastal California) suggests that it probably has the potential to establish in many parts of the EPPO region.

17 - With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area? yes
Based on the current distribution of this pest (see 7) and the damage noted in North America, there is a strong probability that *D. suzukii* could cause significant yield loss and reduction in crop quality in the PRA area.

This pest could present a phytosanitary risk to the PRA area.

18 - Summarize the main elements leading to this conclusion.
Based on the current knowledge and distribution of this pest, its climatic requirements and the agricultural damage it can incur , there is a strong probability that *D. suzukii* could cause significant yield loss and reduction in crop quality in the PRA area.

Stage 2: Pest Risk Assessment - Section B : Probability of entry of a pest

1.1 - Consider all relevant pathways and list them

Possible pathways:

Fruits

D. suzukii lay eggs in fruit. Larvae develop in fruits and pupae usually develop in fruits. The most likely pathways for *D. suzukii* are consequently fruits of host species.

These commodities have been considered in detail in the entry part. Major host fruits and minor host fruits are separated.

D. suzukii has a wide host range (see question 6), nevertheless the EWG considered that a distinction should be made between hosts on which important damage is recorded and thus likely to be major pathways and other hosts:

Major hosts were considered to be:

Rubus armeniacus (Himalayan blackberries), *R. loganobaccus* (loganberries), *R. idaeus* (raspberries), *R. laciniatus* (evergreen blackberries), *R. ursinus* (marionberries), and other blackberries (*Rubus* spp.),

Vaccinium spp (blueberries), .

Fragaria ananassa (strawberries),

Prunus avium (sweet cherries),

P. persica (peaches),

P. armeniaca (apricots)

Minor hosts (or less preferred hosts) were considered to be:

P. domestica (plums),

Vitis vinifera (table and wine grapes).

It should be noted that fruits are the only pathway considered in the PRA conducted for Canada.

The EPPO expert working group considered that a separation between major hosts and minor hosts was useful. No such distinction is made in the Australian PRA .

Plants for planting

Kanzawa (1939) have described the life cycle of *D. suzukii.* It lays eggs in mature fruits. Larvae develop in fruits. Pupation in the fruit seems to be the most frequent form of pupation but some may form between the fruit and the growing media or creep into the soil.

From this information it can be deducted that the main risk for plants for planting is when soil is attached. Infestation could result from fruits that have fallen on the growing media or from pupae which have developed in the growing media.

Plants for planting transported bare rooted are consequently not considered as a likely pathway.

Description of the different commodities for host plants for planting

- Plants of woody trees e.g. *Prunus avium* (sweet cherries), *P. domestica* (plums), *P. persica* (peaches): in nurseries plants usually do not produce fruit as they are too young. Usually plants for planting of fruit trees for professional orchards are traded bare rooted. Fruit trees for private backyard gardens are usually traded in containers but given the poor fruit production the risk is considered negligible.

  The risk of infestation of plants for planting of woody trees is consequently negligible.
- Plants for planting of *Rubus* spp two types of production are recorded for Rubus. *Plants produced in the field are usually traded bare rooted, the risk is consequently negligible*. Other plants for planting are less than two years old and will not set fruits so there is no risk of infestation (Nursery PEPIMAT French nursery specialized in small fruits, pers. comm. 2010).
- *Vaccinium* spp. plants for planting are usually traded in containers and may fruit in nurseries, consequently the growing media attached to the plants may be infested if the plants are produced outdoors.

Information is not sufficient to make a detailed evaluation of the entry part for these pathways (no detailed information on trade for these species, no information on the association or the concentration).

Soil/growing media
Soil from places of production where the pest is present may be infested, though possible, it was considered improbable. This pathway was not considered further

Cut flowers
The Expert Working Group did not consider cut flowers as a relevant pathway at its meeting in July. However, this pathway has been identified in the Australian PRA (Biosecurity Australia, 2010) although considered as presenting a very low risk. The species considered as potential hosts as cut flowers are *Styrax japonicus* and *Camelia japonica*. These species are not recorded as cut flowers in the booklet of the Flower Council of Holland which contains 756 cut flowers in demand (Flower Council of Holland, 2009). Furthermore it is reported that flowers are only known to be attacked by *D. suzukii* in the absence of host fruits. Flowers have only been recorded to be attacked in spring, after adults emerge from winter diapause and before fruits ripen in late spring (Mitsui *et al.* 2010). This pathway is consequently not considered further in this PRA.

Boxes and crates
Larvae and pupae usually remain in the fruit and fruits that are traded are likely to be free from symptoms of attack (so mainly infected with young larvae that will not leave the fruit). It cannot be completely ruled out that some larvae (the most mature) leave the infested fruit during the transportation and wander on the crates to search for a place where to pupate . However, the high humidity requirements for survival during the pupation stage makes that this is a very unlikely pathway.

Natural spread
Natural spread will be possible from areas where the pest has been detected in the EPPO region. This pathway has not been analyzed in detail in the entry section but is considered in the management part.

Commodities that are not pathway
Bulbs and tubers: not relevant
Seeds not relevant
Cut branches without flowers: not relevant
Wood and wood products not relevant

Pathway 1 Fruits of major host plants

1.3b - How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?

very likely
Level of uncertainty: low

Association of the pest with host fruits is very likely in areas where it is present. The pest lays eggs in maturing fruits, larvae and pupae develop in the fruits (Kansawa 1939)

1.4 - How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?

very likely
Level of uncertainty: medium

A detailed study was performed in Japan by Kanzawa in 1939 on cherry.
For cherry in orchards, it was noted that 75 to 80 % of the fruits can be attacked, a variety such as Napoleon being most infested. The possible emergence number in one cherry fruit was also investigated in the laboratory by allowing multi oviposition on one fruit between 40 and 62 hatchings (the size of the adults was smaller than normal but they could reproduce normally). This indicates that several larvae can develop in one fruit.
In his email blog on *D. suzukii* Bolda (2010) states that it continues to be a pest in Japan where it is expanding its

geographical and host range.
Kanzawa (1939) gives the following information for different fruits:

	Cultivar	Condition of Fruit	*D. suzukii* Emergence
Cherries	**Various**	**Whole**	**Many**
Mahaleb Cherry	**-**	**Whole**	**Many**
Somei Yoshino	(P. yedonensis)	Whole	Many
Wild Cherry	(P. donarium)	Whole	Many
Korean Cherry	(P. japonica)	Whole	Many
Japanese Raspberry	**(*Rubus incises/R. microphyllus*)**	**Whole**	**Many**
Threeleaf blackberry	**(Rubus triphyllus)**	**Whole**	**Many**
Strawberry	**Fukuba**	**Whole**	**Many**
Grapes	Black Hamburgh	Whole	Many
Grapes	Gros Coleman	Whole	Many
Grapes	Golden Queen	Whole	Many
Grapes	Herbert	Whole	Few
Grapes	Foster"s Seedling	Whole	Few
Grapes	Muscat of Alexandria	Whole	Many
Grapes	Muscat Hamburg	Whole	Many
Silver Berries	(Elaeagnus multiflora)	Whole	Few
Mulberries	(Morus alba)	Whole	Few
Apples	-	Damaged	Few
Peaches	**-**	**Dropped, Damaged**	**Many**
Plums	Terada	Whole	Few
Persimmons	-	Ripen, Split	Few
Apricots	**-**	**Dropped**	**Few**

Table 2 Investigation on Fruit Collected in the Field (1934, 1935), Kanzawa, 1939.(major hosts in bold)

In California, Oregon and Washington (USA) average yield reductions attributed to *D. suzukii* range from 40% for blueberries, 50% for blackberries and raspberries and 33% for cherries. As it is directly linked to fruit infestation, it can be assumed that this directly relates to an equivalent concentration on the fruits. These figures depend on locations too. There is no specific information on infestation percentage in fruits.

1.5 - How large is the volume of the movement along the pathway?
(Note that only imports from outside the region were considered in the analysis no reliable figure exist for internal movement within the region)

minor

Level of uncertainty: low

Volumes of imports into EU countries of fruits of host plants from countries where the pest occurs have been retrieved from EUROSTAT for the years 2007 to 2009 (volume in 100 kg).
Compared to the total volumes of imports of fruits, these imports usually represent less than 10% of the imports in the same category for all fruits. It ranges from 13 to 16% for *Vaccinium*. The volumes are consequently considered

as minor with low uncertainty.

Table 3 Volumes of import for major fruits for the years 2007 to 2009 (volume in 100 kg source EUROSTAT).

PRODUCT	Origin	2007	2008	2009
Fresh cherries	Canada	13864	8311	12170
	China (people's republic of)	0	0	288
	India	0	0	2
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	54250	41972	37683
	Total infested countries	68114	50283	50143
	Total imports (all origins)	601898	332922	438410
Fresh cherries	Percentage of total imports	11	15	11
Fresh strawberries	Canada	0	0	0
	China (people's republic of)	0	4	0
	India	0	6	0
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	46475	37225	22034
	Total infested countries	46475	37235	22034
	Total imports (all origins)	404522	432940	430434
Fresh strawberries	Percentage of total imports	11	9	5
Other berries	Canada	0	0	0
	China (people's republic of)	107	248	255
	India	0	0	1
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	11959	6677	5535
	Total infested countries	12066	6925	5791
	Total imports (all origins)	149162	114976	115023
	Percentage of total imports	8	6	5
Fresh vaccinium	Canada	3216	9182	5535
	China (people's republic of)	64	493	1068

PRODUCT	Origin	2007	2008	2009
	India	0	0	0
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	17200	12599	12543
	Total infested countries	20480	22274	19146
	Total imports (all origins)	127625	138674	142456
Fresh vaccinium	Percentage of total imports	16	16	13

Fresh peaches	Canada	0	0	0
	China (people's republic of)	980	0	50
	India	0	0	0
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	20982	17247	2311
	Total infested countries	21962	17247	2361
	Total imports (all origins)	416789	425390	358977
Fresh peaches	Percentage of total imports	5	4	1

1.6 - How frequent is the movement along the pathway?

Occasionally to often

Level of uncertainty: low

Imports of the different fruits from infested countries occur mainly during summer months apart for *Vaccinium* which has a much wider period of import.
According to the rating guidance proposed by MacLeod & Baker (2003) Import can be considered as occasional to often depending on the fruits (up to 4 months of the year corresponds to occasionally, up to 8 months of the year corresponds to often)

Table 4 Repartition of the imports of fruits across the year 2009

Partner	period	Cherries	Strawberries	Raspberries..	Vaccinium
Canada	Jan. 2009	0	0	0	0
	Feb. 2009	0	0	0	0
	Mar. 2009	0	0	0	17
	Apr. 2009	0	0	0	29
	May. 2009	0	0	0	0
	Jun. 2009	0	0	0	170

Partner	period	Cherries	Strawberries	Raspberries..	Vaccinium
	Jul. 2009	1210	0	0	668
	Aug. 2009	9990	0	0	0
	Sep. 2009	624	0	0	24
	Oct. 2009	0	0	0	2665
	Nov. 2009	346	0	0	1962
	Dec. 2009	0	0	0	0
China	Jan. 2009	0	0	0	250
	Feb. 2009	0	0	0	500
	Mar. 2009	0	0	0	250
	Apr. 2009	0	0	0	0
	May. 2009	0	0	202	24
	Jun. 2009	0	0	53	44
	Jul. 2009	0	0	0	0
	Aug. 2009	188	0	0	0
	Sep. 2009	0	0	0	0
	Oct. 2009	0	0	0	0
	Nov. 2009	0	0	0	0
	Dec. 2009	100	0	0	0
United states	Jan. 2009	0	0	337	158
	Feb. 2009	0	108	451	0
	Mar. 2009	0	15	115	314
	Apr. 2009	5	75	68	1216
	May. 2009	2175	843	350	29
	Jun. 2009	2061	7233	384	714
	Jul. 2009	11134	3614	392	1045
	Aug. 2009	19608	3746	647	0
	Sep. 2009	2661	2789	763	451
	Oct. 2009	39	1812	1005	2387
	Nov. 2009	0	1691	745	5411
	Dec. 2009	0	108	278	818

1.7 - How likely is the pest to survive during transport /storage?

Very likely

Level of uncertainty: low

Kanzawa (1939) reports experiments made regarding the sensitivity of eggs and larval stages to periods of temperature above and below freezing (0°C). At constant temperature of up to 1.66 °C for 96 hours or more cooling resulted in total mortality of spotted wing drosophila eggs and larvae. Bolda (blog article dated 2010-03-23) states that for success it is important that temperature remains constant for periods longer than 96 hours.

Precise temperature conditions for the transport of fruits are not known but it is very likely that the fruits concerned will be transported by air freight. 1.66°C is low and guaranteeing such constant temperature is likely to be a challenge given the loading and uploading procedures. In addition transport time is likely to be much less than 96 hours.

1.8 - How likely is the pest to multiply/increase in prevalence during transport /storage?

impossible/very unlikely

Level of uncertainty: low

Larvae and pupae are likely to be present in the fruit but if an adult emerges it will not be very active.
Kanzawa (1939) states adults remain motionless at 5°C and begin to crawl at 10°C which is likely to be above the transport temperature. So it is very unlikely that the pest will multiply during transport.

1.9 - How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?

very likely

Level of uncertainty: low

Early infestations are difficult to detect nevertheless it also depends on the hosts. On cherries or Vaccinium infested fruits show small scars and indented soft spots on the fruit surface left by the females ovipositor ("stinger") (Dreves *et al.* 2009). On other fruits (*Rubus* spp, *Fragaria, Prunus*) infestation is more difficult to detect due to the uneven or hairy surface. Eggs and respiratory tubes will be difficult to see.

In EU countries and countries with EU like legislation a phytosanitary certificate is not required for the importation of *Rubus* fruits. A Phytosanitary certificate is required for fruits of *Prunus*, and *Vaccinium* but no specific requirements that would be appropriate for *D. suzukii* are in place.
It should be noted that cherry fruits in the northern states of North America are routinely checked for infection with *Rhagoletis* spp. before export (so for these fruits the likelihood of infestation is lower).

1.10 - How widely is the commodity to be distributed throughout the PRA area?

moderately widely

Level of uncertainty: medium

There is no information available to make a judgment on this question. The medium rating was chosen.

1.11 - Do consignments arrive at a suitable time of year for pest establishment?

yes

Level of uncertainty: low

The countries were the pest is present are located in the same hemisphere so the fruits (which have a short lifetime) will be exported during summer or autumn, so in a suitable time. In addition, if imported late in the season eggs or larvae present in the fruits, may hatch in houses or ware houses and adults will over winter.

1.12 - How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?

moderately likely

Level of uncertainty: medium

For the transfer to occur a sequence of events is necessary.
Several scenarios could happen (from the most likely to the less likely to aid transfer):

- Adults may escape from storage places and houses
- Fruits may be sold at the road in front of a fruit orchard (this is at least reported for cherries in the Netherlands, Potting pers. comm. 2011) . In the beginning of the season (when cherries are still not ripe) cherries from Southern Europe are sold at these stalls. For an emerging *D. suzukii* it would be easy to find a suitable oviposition site in the neighbouring orchard.
- Infested fruits are discarded to a compost pile and some adults may escape (compost piles are believed to be suitable as hibernation sites)
- Infested fruits are thrown away; garbage is not collected regularly and the pest may escape.
- Infested fruits are thrown away in a bin in a country with regular garbage collection and garbage is incinerated.

There is a high probability that the pest will escape and fly outdoors and it will be easy for the pest to find a suitable host as host plants are very common plants in backyard gardens. There is no information available as to whether pheromones are involved in the process of finding a mate.

1.13 - How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?

moderately likely

Level of uncertainty: medium

Usually it is considered that consumption does not favour transfer. Nevertheless the fruits are intended to be consumed fresh and if they are damaged the risk that they will be discarded is higher. In such case adults can escape.

Pathway 2 Fruits of minor host plants

1.3b - How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?

moderately likely

Level of uncertainty: low

Based on the information available for hosts considered as less attractive, association of the pest with the fruits is moderately likely (the fly will mainly be attracted to these fruits if other fruits are not available). The pest lays eggs in maturing fruits, larvae and pupae develop in the fruits (Kansawa 1939)

1.4 - How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?

moderately likely

Level of uncertainty: medium

There is little information for other fruits. Regarding grapes and some other fruits, Kanzawa (1939) gives the following information :

Table 5 Extract Investigation on Fruit Collected in the Field (1934, 1935), Kanzawa, 1939.

	Cultivar	Condition of Fruit	*D. suzukii*
Grapes	Black Hamburgh*	Whole	Many
Grapes	Gros Coleman *	Whole	Many
Grapes	Golden Queen *	Whole	Many
Grapes	Herbert	Whole	Few
Grapes	Foster"s Seedling	Whole	Few
Grapes	Muscat of Alexandria*	Whole	Many
Grapes	Muscat Hamburg*	Whole	Many
Mulberries	(Morus alba)	Whole	Few
Plums	Terada	Whole	Few

*thin skin grapes.

The information published by Kanzawa in 1939 for grapes is not confirmed by current observations in California. The pest is present in cherry orchards in the vicinity of vineyards and no damage has been recorded in these vineyards so far (Hauser, pers. comm. 2010).

1.5 - How large is the volume of the movement along the pathway?
Note that only imports from outside the region were considered in the analysis no reliable figure exist for internal movement within the region)

minor

Level of uncertainty: low

Volumes of imports into EU countries of fruits of host plants from countries where the pest occurs have been retrieved from EUROSTAT for the years 2007 to 2009[1] (volume in 100 kg)
Compared to the total volumes of imports of fruits these imports usually represent less that 10% of the imports in the same category for all fruits.
The volumes can be considered as minor with low uncertainty.

Table 6 Volumes of imports (in 100 kg) into EU countries of fruits of minor host plants from countries where the pest occurs (source EUROSTAT)

Fresh grapes	Canada	0	153	0
	China (people's republic of)	1195	737	0
	India	279464	407098	362017
	Japan	0	0	2
	Republic of south Korea	0	8	0
	Myanmar (Burma)	0	0	0
	United States	96713	103972	103830
	Total infested countries	377372	511968	465849
	Total imports	6194043	6543002	6136393
Fresh grapes	Percentage of total imports	6	8	8
Fresh plums	Canada	0	0	0
	China (people's republic of)	1	1	1
	India	0	0	0
	Japan	0	0	0
	Republic of south Korea	0	0	0
	Myanmar (Burma)	0	0	0
	United States	4348	1249	1403
	Total infested countries	4349	1250	1404
	Total imports (all origins)	875512	895765	825457
Fresh plums	Percentage of total imports	0,5	0,1	0,2

1.6 - How frequent is the movement along the pathway?

often

Level of uncertainty: low

Repartition of imports of the different fruits for the different infested countries is mainly spread during summer months.
According to the rating guidance proposed by MacLeod & Baker (2003) frequency of importation can be considered as often.

Table 7 Repartition of the imports of fruits across the year 2009

[1] http://epp.eurostat.ec.europa.eu/portal/page/portal/external_trade/data/database

Partner	period	Grapes	Plums
India	Jan. 2009	0	0
	Feb. 2009	1249	0
	Mar. 2009	42677	0
	Apr. 2009	202994	0
	May. 2009	114052	0
	Jun. 2009	675	0
	Jul. 2009	120	0
	Aug. 2009	0	0
	Sep. 2009	0	0
	Oct. 2009	0	0
	Nov. 2009	250	0
	Dec. 2009	0	0
United states	Jan. 2009	0	0
	Feb. 2009	0	0
	Mar. 2009	0	0
	Apr. 2009	9	0
	May. 2009	0	421
	Jun. 2009	792	827
	Jul. 2009	4732	0
	Aug. 2009	8550	0
	Sep. 2009	10357	13
	Oct. 2009	24692	142
	Nov. 2009	38894	0
	Dec. 2009	15804	0

1.7 - How likely is the pest to survive during transport /storage?

likely

Level of uncertainty: low

(same text as previous pathway)

Kanzawa (1939) reports experiments made regarding the sensitivity of eggs and larval stages to periods of temperature above and below freezing (0°C). At constant temperature of up to 1.66 °C for 96 hour or more cooling resulted in total mortality of spotted wing drosophila eggs and larvae. Bolda (blog article dated 2010-03-23) states that for success it is important that temperature remains constant for periods longer than 96 hours.

Precise temperature conditions for the transport of fruits are not known but it is very likely that the fruits concerned will be transported by air freight. 1.66°C is low and guaranteeing such constant temperature is likely to be a challenge given the loading and uploading procedures.

1.8 - How likely is the pest to multiply/increase in prevalence during transport /storage?

impossible/very unlikely

Level of uncertainty: low

(same text as previous pathway)

Larvae and pupae are likely to be present in the fruit but if an adult emerges it will not be very active.

Kanzawa (1939) states adults remain motionless at 5°C and begin to crawl at 10°C which is likely to be above the transport temperature. So it is very unlikely that the pest will multiply during transport. In addition transport time is likely to be much less than 96 hours.

1.9 - How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?

very likely

Level of uncertainty: low

Early infestation are difficult to detect nevertheless it also depends on the hosts. On fruits such as *Prunus* infestation is more difficult to detect due to the hairy surface. Eggs and respiratory tubes will be difficult to see.

In EU countries and countries with EU like legislation a phytosanitary certificate is not required for the importation of Vitis fruits. A Phytosanitary certificate is required for fruits of *Prunus* but no specific requirements that would be appropriate for *D. suzukii* are in place.

1.10 - How widely is the commodity to be distributed throughout the PRA area?

moderately widely

Level of uncertainty: high

There is no information available to make a judgment on this question. The medium rating was chosen.

1.11 - Do consignments arrive at a suitable time of year for pest establishment?

yes

Level of uncertainty: low

(same text as previous pathway)

The countries were the pest is present are located in the same hemisphere so the fruits (which have a short lifetime) will be exported during summer or autumn, so in a suitable time. In addition, if imported late in the season eggs or larvae present in the fruits, may hatch in houses or ware houses and adults will over winter.

1.12 - How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?

moderately likely

Level of uncertainty: medium

(same text as previous pathway)

For the transfer to occur a sequence of event should occur.

Several scenarios could happen (from the most likely to the less likely to aid transfer):

- Adults may escape from storage places and houses
- Fruits may be sold at the road in front of a fruit orchard (this is at least reported for cherries in the Netherlands, Potting pers. comm. 2011) . In the beginning of the season (when cherries are still not ripe) cherries from Southern Europe are sold at these stalls. For an emerging *D. suzukii* it would be easy to find a suitable oviposition site in the neighbouring orchard.
- Infested fruits are discarded to a compost pile and some adults may escape (compost piles are believed to be suitable as hibernation sites)
- Infested fruits are thrown away; garbage is not collected regularly and the pest may escape.
- Infested fruits are thrown away in a bin in a country with regular garbage collection and garbage is incinerated.

There is a high probability that the pest will escape and fly outdoors and it will be easy for the pest to find a suitable host as host plant are very common plants in backyard gardens. There is no information available as to whether pheromones are involved in the process of finding a mate.

1.13 - How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?

moderately likely

Level of uncertainty: medium

Usually it is considered that consumption does not favour transfer. Nevertheless the fruits are intended to be consumed fresh and if they are damaged the risk that they will be discarded is higher. In such case adults can escape.

1.14c - The overall probability of entry should be described and risks presented by different pathways should be identified

The EWG considered that the risk of entry was high with a low uncertainty for the main host fruits. The fact that the pest has established in Italy and France and was also introduced in the US and Canada was considered as a strong indication that the pest can enter easily. Volumes of imports are not large but the concentration of the pest is likely to be very high on the fruits.

For minor host fruits, the risk is considered as medium with low uncertainty; the difference is due to the fact that the concentration of the pest is not likely to be very high on these hosts, and the fact that they are less likely to be infested than the major hosts.

I should be noted that movement of host fruits within the region have not been included in this analysis consequently the risk may be higher.

Stage 2: Pest Risk Assessment - Section B : Probability of establishment

1.15 - Estimate the number of host plant species or suitable habitats in the PRA area.

Answer given to question 6 :

moderate number

Level of uncertainty: low

D. suzukii is recorded on many soft-skin fruits (see question 6), the majority of which are grown in the PRA area. As it is restricted on soft skin fruits the EWG considered that this supports a rating of moderate number.

1.16 - How widespread are the host plants or suitable habitats in the PRA area? (specify)

widely

Level of uncertainty: low

Production figures for Europe, North Africa, West Asia (Source FAO Stat accessed 2010/07/02 detailed table are presented in Appendix 2)

Table 8 Preferred host crops

Fruit	Surface ha 2007	Surface ha 2008
Cherries	265756	280447
Strawberries	207760	195010
Raspberries	92784	82167
Blueberries	17365	17504
Current	139890	115548
Other berries	38632	38964
Apricot	282160	271968
Peaches and nectarines	412533	468637
Total (hosts)	1455880	1470245
Total all fruits (including non-hosts)	12871995	12790219

This represents approximately 12% of the total area of fruit production.

Potential hosts are present all over the region (see detailed tables in Appendix 2 below showing surfaces harvested in 2008 for different major host crops).

Table 9 Other host crops

Fruit	Surface ha 2007	Surface ha 2008
Grapes	4996765	5040451
Total "hosts + Grapes	6453645	6510696
all fruits	12871995	12790219

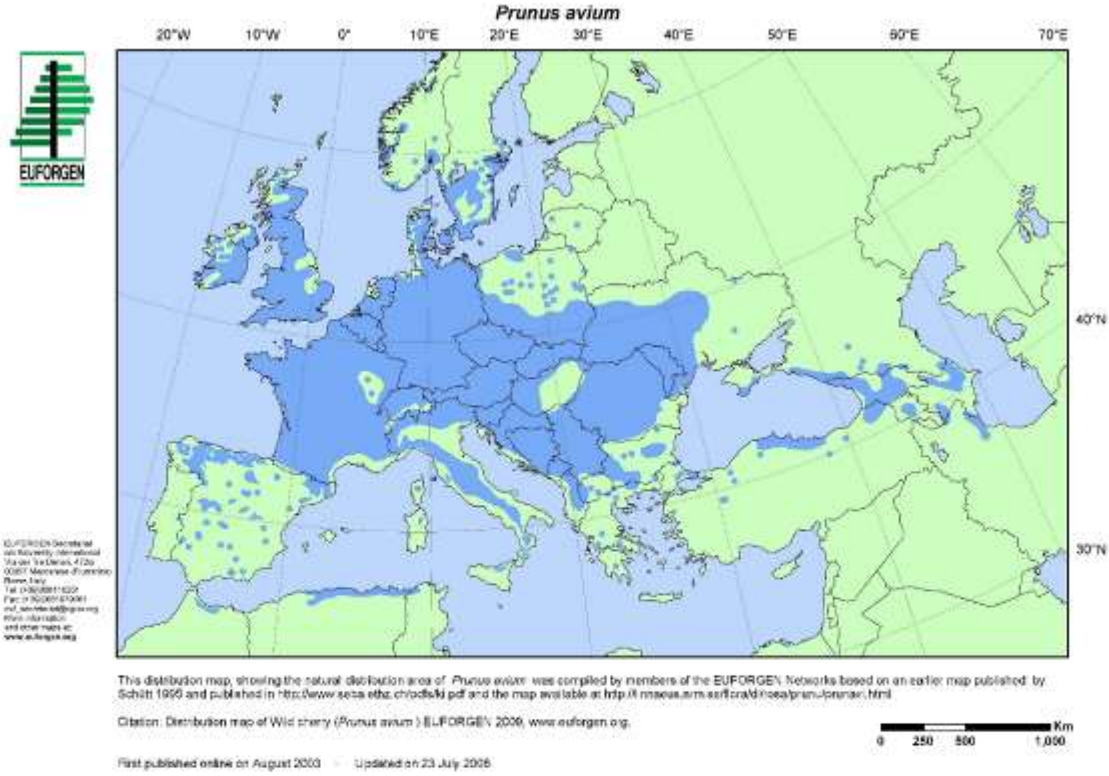
With vineyards this represents 50% of the total of fruit production.

Ornamental species

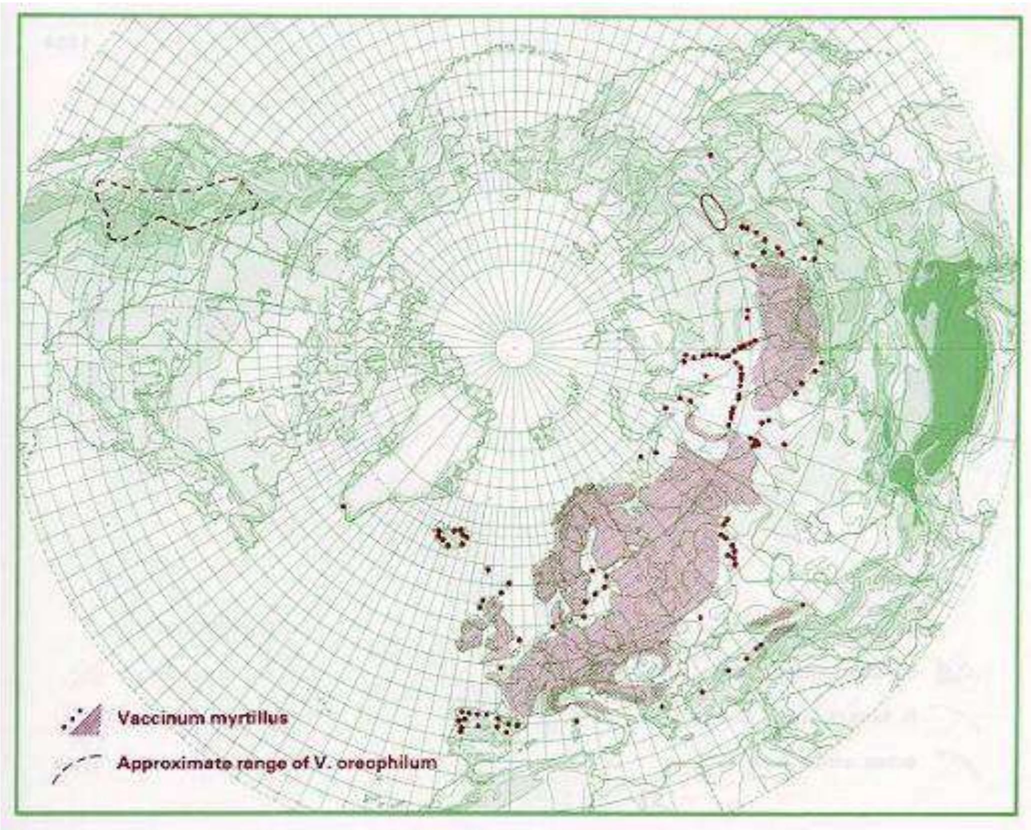
Prunus are widely grown and used for ornamental purposes in the PRA area (Cullen, 1995).

Wild species

Wild species of host plants are widely distributed in the wild in the PRA area e.g. *Prunus avium* (EUFORGEN, 2009)



Distribution map for *Vaccinium myrtillus*



Source: http://linnaeus.nrm.se/flora/di/erica/vacci/vaccmyrv.jpg

1.17 - If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?

N/A

Level of uncertainty: low

1.18a - Specify the area where host plants (for pests directly affecting plants) or suitable habitats (for non parasitic plants) are present (cf. QQ 1.15-1.17).
This is the area for which the environment is to be assessed in this section. If this area is much smaller than the PRA area, this fact will be used in defining the endangered area.

Plants are present nearly all over the EPPO region except in the most northern parts.

1.18b - How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?

largely similar

Level of uncertainty: medium

Visual examination of the Köppen-Geiger climate zones, hardiness zones and degree day maps shows that the climate in its current area of distribution is largely similar to that in the PRA area where hosts are present. Only northern areas of Europe and Russia where hosts are present are unsuitable. In many areas, there are sufficient accumulated degree days for numerous generations to be completed in the summer. Although 250 degree days is required for development from egg to adult, a simple division of the annual degree days to obtain a map of the number of generations possible in an area was not considered very appropriate because (a) an additional period is usually required by insects before adults are ready to oviposit, (b) considerable individual variation can be expected with overlapping generations occurring and (c) the grid cells summarise and interpolate climate measured at weather stations and many locations within each grid cell will have different temperature accumulations. Although the higher the degree day accumulation above 10ºC, the greater the number of generations expected, the species cannot tolerate high temperatures if humidities are low and, in the southern Mediterranean areas, the species may survive only in irrigated crops. Information from Trentino-Alto Adige region suggests that the species can be abundant even in areas where the degree day accumulations indicate that only one or two generations per year can be completed.

The pest overwinters as adult consequently cold winters are not favourable for its survival however, Kimura (pers. comm.) considers that in Hokkaido, severe winter causes high mortality but population survives in habitats associated with human habitation and is increased by entry with fruit imports from elsewhere in Japan.

See Appendix 3 for a detailed analysis and maps.

1.19 - How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?

no judgement

Level of uncertainty: low

From the literature available, no other abiotic factors are recorded as playing a role in establishment of *D. suzukii*.

1.20 - If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?

never

Level of uncertainty: low

D. suzukii has never been recorded on fully protected crops i.e. glasshouse situations. However, the opportunity for the infestation of greenhouses (e.g. protected berries) exists. Raspberries are produced under tunnels in many locations, however, these are open tunnel situations. In California infestations have been seen under these situations (Hauser, pers. comm., 2010).

1.21 - How likely is it that establishment will occur despite competition from existing species in the PRA area, and/or despite natural enemies already present in the PRA area?

very likely

Level of uncertainty: low

The outbreak in Italy proved that presence of potential natural enemies was not sufficient to prevent establishment. Nevertheless, the situation might be different in other parts of the PRA area, e.g. there could be competition with *Rhagoletis* on cherry.

There is no data on biological control but it is mentioned in the Japanese literature that larvae of *D. suzukii* were naturally parasitized by a species belonging to the genus *Phaenopria* (Hymenoptera: Diapriidae) (EPPO, 2010). Mitsui *et al. (*2007) report that *Ganapsis xanthopoda* is parasitizing *D. suzukii* in the main islands of Japan, but recent studies have shown that the *Ganapsis* species attacking *D. suzukii* is a new species which is not named so far, studies are being conducted (Kimura, pers. comm. 2010).

There may be potential for biocontrol in fruit crops such as blueberries with generalist rove beetles such as *Atheta coriaria*. However, there is as yet, little information available (Hueppelsheuser pers. comm., 2010).

For competition there is no information in the literature. To date there is no evidence of competition in N. America where other fruit flies are present.

Despite the possibility of competition the EWG considered the uncertainty to be low.

1.22 - To what extent is the managed environment in the PRA area favourable for establishment?

very highly favourable

Level of uncertainty: medium

Susceptible crops are grown in monoculture. The high density of planting in orchards and fruit fields (e.g. strawberries) favour the establishment of the pest. Host plants can also be found in the wild, in gardens or in amenity areas in the vicinity of orchards and can therefore act as reservoir of the pest, even if management measures are applied in cultivated orchards .

Little information was available to the EWG on the management of the crop by producers i.e. whether they can favour or not establishment. It is known that with regard to soft fruit crops, cultural practices such as covering are used to prolong the cropping season (e.g. in Tayside, Scotland), thereby potentially increasing host availability to *D. suzukii*. However, the EWG had no specific information or evidence to suggest that such practices had influenced *D. suzukii* populations. Conversely, for *D. suzukii* management, there may be scope to use either late or early fruiting varieties.

1.23 - How likely is it that existing pest management practice will fail to prevent establishment of the pest?

very likely

Level of uncertainty: low

Pest establishment did occur in Italy and France despite of the managed environment.

Organic orchards, private gardens and amenity areas are more favourable to establishment due to reduced plant protection product use.

In many orchards and soft fruit crops few insecticides are used particularly before harvest. Most of the listed insecticides in fruit production are not effective against *D. suzukii* or cannot be used at the most efficacious moment due to the regulated pre-harvest interval. *D. suzukii* oviposits on ripe fruits in the later stages of development, just before harvest which therefore hampers the control of the pest with insecticides.

Specific information was gathered from France (Alpes Maritimes) on the pest management practices in strawberry production (Risso, pers. comm. to Reynaud, 2010). Most strawberry production in this area is under integrated pest management. In places of productions managed under integrated pest management few plant protection products are used. In conventional strawberry production growers only apply plant protection products when they detect the pest and not as a preventive pest management programme. Insecticide treatments in strawberry are mainly targeting thrips infestations. Spinosyn (spinosad) was used against thrips in 2010 with a temporary authorization (this plant protection product is about to be authorized). Spinosad has shown some efficacy under trial conditions in North America.

1.24 - Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?

very likely

Level of uncertainty: low

Considering the life cycle with up to 15 generations (Kanzawa, 1935), the fast development time (8 to 14 days in optimal conditions), some 400 eggs laid per female (maximum of 992 eggs/female), duration of oviposition of 55 days (maximum of 99 days) (Kanzawa, 1939) and high insect mobility (see question 1.30), it is very unlikely that it will be possible to eradicate the pest in infested areas without natural barriers. If the infestation is detected early in a small and restricted area (like a valley) with low abundance and well implemented measures there is a chance for eradication.

1.25 - How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?

very likely

Level of uncertainty: low

This species is a typical r-strategist with high fluctuations in abundance in unstable or unpredictable environments. Under these conditions, r-selection predominates as the ability to reproduce quickly is crucial. Under good climatic and resource conditions, *D. suzukii* has a high reproduction rate up to 15 generations (Kanzawa, 1935). A small number of adults should be sufficient to build up a large population over the growing season. The distribution in USA and Canada underline this potential.

The adult appears to be able to survive long periods under cold conditions and with limited resources.

See also 1.18

1.26 - How likely are relatively small populations to become established?

very likely

Level of uncertainty: low

The rapid life cycle in summer temperatures, potential for many adults to emerge from one infested fruit (over 60) and the low relatedness of these individuals (each female lays only 2-3 eggs on a fruit) means that one fruit could carry the basis for a new population without a severe genetic bottleneck occurring (Damus, 2010).

See also 1.24 and 1.25

1.27 - How adaptable is the pest?

very high adaptability

Level of uncertainty: low

The native habitat of this fly ranges in Asia from northern China and southern Siberia to northern India, and then south-east to Hainan island in China. It is also known in Taiwan, Korea, Thailand and Burma. It has also been introduced to Hawaii, the USA (Florida, California, Oregon and Washington) and is now present in Canada (British Columbia: from Delta to Chilliwack) (Kanzawa, 1939; Damus, 2010).

In Europe there were introductions in Italy (Trentino-Alto Adige region) in 2009 and a notification of Spain (130 km from the south west of Barcelona) in 2010 (Baufeld *et al.,* 2010). However, the pest is restricted by severe winter conditions (frost) and high summer temperatures (above 32 °C). (pers. comm. Smyth 2010, see also 1.18).

1.28 - How often has the pest been introduced into new areas outside its original area of distribution? Specify the instances if possible in the comment box.

often

Level of uncertainty: medium

The pest was introduced to a minimum of four continents in several countries (for the USA the state records were considered as individual records). There is no information about Asia. But probably also in Japan/China depending where the species is native from.

1.29 - How likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment)?

moderately likely

Level of uncertainty: medium

Certainly the main threat of human assisted spread is through the transport of infested fruits (Damus, 2010).
Transient populations could occur in areas of the EPPO region with cooler climates, e.g. some northern and eastern parts of the PRA area (Scandinavia, Eastern Europe/Russia)

1.29c - The overall probability of establishment should be described.

The risk of establishment was considered to be high with a low uncertainty. This is due to the fact that host plants are widely present in the PRA area (cultivated but also backyard plants). Climatic conditions are suitable (only northern areas of Europe and Russia where hosts are present are unsuitable). The management practices can be adapted but the experience so far in the parts of the PRA area where the pest has established was that they could not prevent *D. suzukii* establishment. The EWG debated whether this should be considered very high but as the PRA area included parts where climate is not suitable (see above), the final conclusion was high.

Stage 2: Pest Risk Assessment - Section B : Probability of spread

1.30 - How likely is the pest to spread rapidly in the PRA area by natural means?

likely

Level of uncertainty: high

The EWG considered it difficult to give a precise indication on spread capacity of *D. suzukii* and considered natural spread as moderately likely with a medium uncertainty.
There is no specific data available on the potential flight capacity of *D. suzukii*. Studies made on other species of Drosophilidae indicate a flight distance up to 45 km per generation (Johnston and Heed, 1976). In the closely related *Drosophila melanogaster*, directional flights to preferred habitats of several hundred meters have been recorded (Coyne *et al.,* 1987). During the same study, another species *D. pseudoobscura* was caught in many remote desert locations as far as 26 km from the nearest likely breeding site (Coyne *et al.,* 1987).
Migration from low to high altitude is reported (Mitsui *et al.,* 2010) but no indication of distances involved is given in the article. The fly can also be transported by wind current.
The presence of natural barriers such as arid areas, mountain ranges, climatic differentials and possible long distances between hosts may prevent long-range natural spread of *Drosophila suzukii*. Availability of host plants will facilitate spread.

1.31 - How likely is the pest to spread rapidly in the PRA area by human assistance?

very likely

Level of uncertainty: low

Undetected infested fruits can travel long distance and this is considered to have been the most likely pathway of introduction into new areas (Hauser *et al.,* 2009).

1.32 - Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?

likely

Level of uncertainty: low

Movement of the pest with infested fruits will be difficult to control in the PRA area as early infestations are difficult to detect. Determining containment measures will be difficult given that natural spread capacity is undetermined.

1.32c - The overall probability of spread should be described.

The risk of spread is considered high (uncertainty: low)

Spread noted so far is a consequence of both human and natural spread. Human spread is very likely but the natural spread capacity is uncertain. The EWG decided to rate the probability of spread as 'high', though not 'very high', for that reason.
Drosophila suzukii was first reported in North America in 2008 in California and by 2009 was widespread in a range of hosts from Oregon, Washington (Hauser *et al.,* 2009) and British Columbia (BCMAL, 2009). This demonstrates the

ability of *Drosophila suzukii* to spread if suitable hosts are present and climatic conditions are favourable. The pest has also spread in France (EPPO, 2010c).

Stage 2: Pest Risk Assessment - Section B : Conclusion of introduction and spread and identification of endangered areas

The overall probability of introduction and spread should be described. The probability of introduction and spread may be expressed by comparison with PRAs on other pests.

1.33a - Conclusion on the probability of introduction and spread.

Entry

The EWG considered that the risk of entry was high with a low uncertainty for the main host fruits. The fact that the pest has established in Italy and France and was also introduced in the US and Canada was considered as a strong indication that the pest can enter easily. Volumes of imports are not large but the concentration of the pest is likely to be very high on the fruits.

For minor host fruits, the risk is considered as medium with low uncertainty. The difference is due to the fact that the concentration of the pest is not likely to be very high on these hosts, and the fact that they are less likely to be infested than the major hosts.

Establishment

The risk of establishment was considered to be high with a low uncertainty. This is due to the fact that host plants are widely present in the PRA area (cultivated but also backyard plants). Climatic conditions are suitable (only northern areas of Europe and Russia where hosts are present are unsuitable). The management practices can be adapted but the experience so far in the parts of the PRA area where the pest has established was that they could not prevent *D. suzukii's* establishment. The EWG debated whether this should be considered very high but as the PRA area included parts where climate is not suitable (see above), the final conclusion was high.

Spread

The risk of spread is considered high (uncertainty: low)

Spread noted so far is a consequence of both human and natural spread. Human spread is very likely but the natural spread capacity is uncertain. The EWG decided to rate the probability of spread as 'high', though not 'very high', for that reason.

Drosophila suzukii was first reported in North America in 2008 in California and by 2009 was widespread in a range of hosts from Oregon, Washington (Hauser *et al.,* 2009) and British Columbia (BCMAL 2009). This demonstrates the ability of *Drosophila suzukii* to spread if suitable hosts are present and climatic conditions are favourable. The pest has also spread in France (EPPO, 2010c).

1.33b - Based on the answers to questions 1.15 to 1.32 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.

Hosts are very widespread in the EPPO region except for the extreme north and the arid areas of Asia and in most of these areas, the climate is suitable for establishment. Apart from climate, no other biotic or abiotic factor limits distribution. Currently, *D. suzukii* is found in areas with the extremely cold temperatures of -35ºC that occur in hardiness zone 4, however, based on Kimura (pers. comm., 2010), in these areas, survival may depend on the availability of suitable over-wintering habitats associated with human habitation.

Stage 2: Pest Risk Assessment - Section B : Assessment of potential economic consequences

2.1 - How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?

massive

Level of uncertainty: medium

North America

In less than two years, *D. suzukii* spread along the West Coast of North America, from California's Central Valley to British Columbia (Lies, 2009) and damage has been recorded. Several berry growers in California, Oregon and Washington have reported up to 100% crop losses in some fields. In Willamette Valley (Oregon) peach growers experienced losses of up to 80 % in some orchards (Herring, 2009). In 2009, California lost some one-third of its cherry crop from Davis to Modesto. Crop losses up to 20 % were seen in Oregon raspberries (Herring, 2009). In addition, the spotted wing drosophila has been found infesting the fruit of raspberry, blackberry, blueberry, and strawberry plantings on the central coast. It was estimated that 25% of late season blueberries and raspberries in Oregon were destroyed (Lies, 2009).

However it should be noted that recent experience in California has demonstrated that damage can be quite sporadic. The pest is quite sensitive to local climate factors and damage is determined by whether or not conditions are optimal. Therefore different patterns of damage are seen.

Bolda *et al.* (2009a) produced an economic impact study of the effect of *D. suzukii* on the three main fruit production States in the US, California (Ca), Oregon (Or) and Washington (Wa). The study uses both a mean assumption of 20 % yield loss and then examines actual maximum yield losses observed in 2008 as illustrated below.

Table 10 Revenue losses associated with *D. suzukii* (Bolda *et al*., 2009)

Crop	**2008 total crop value ($ million) for states: Ca, Or, Wa.**	**Revenue losses ($ million) based on 20 % yield loss**	**Revenue losses ($ million) based on 2008 maximum observed US loss figures**
Strawberry	1571.5	314.3	33.4 (2.1 % loss)
Blueberry	141.9	28.4	56.7 (40 % loss)
Raspberry and blackberry	313.3	62.7	156.6 (50 % loss)
Cherries	550.3	105.9	174.8 (32 % loss)

These figures demonstrate the variable nature of *D. suzukii* infestation, host preference and the range of the extent in terms of repercussions on crop losses. However, this may change rapidly as the pest exploits and develops on other hosts in its environment.

Oceania

In 1980 the species was collected on a single Hawaiian island and was then observed to spread to several other Islands of Hawaii, though without any reports of it causing damage. It is likely that this is due to the fact that there are few suitable commercial host crops in this location (Hauser *et al.,* 2009).

EPPO region

In the part of the PRA area where the pest has been detected the situation is as follows:

In 2010 losses of up to 80% occurred in strawberry crops of the Alpes Maritimes region of southern France (pers. comm. Reynaud, 2010). Similar losses have also been quoted in raspberries in the Trentino-Alto Adige region (pers. comm. Grassi, 2010).

Asia

Regarding *D. suzukii* damage in Asia, there is clear evidence of *D. suzukii* infestation of blueberry in Kisarazu City, Chiba Prefecture, Japan (Uchino, 2005). Blueberries from three areas out of five investigated areas of the province showed *D. suzukii* damage. In the PRA prepared by biosecurity Australia it is reported that *D. suzukii* has been recorded to be the main pest damaging cherry in Fukushima Prefecture (Sasaki and Sato, 1995a). Damage levels are low at the start of harvest and have been recorded to reach a maximum of 77% by the end of the season (Sasaki and Sato, 1995a). Investigation by the EWG shows that crops prone to damage such as cherry and late ripening berry fruits, tend not to be important crops in Japan and areas of China in which *D. suzukii* occur (pers. comm. M. Kimura, Hokkaido University, 2010). In addition Kumura commented that even if serious damage occurs it is not likely to be widely reported.

Uncertainty level: medium. The EWG based this decision on the information that was available, but acknowledged that there was limited information available for some regions such as China, where it is known that *D. suzukii* could affect thin skinned fruit crops and consequently the level of uncertainty regarding damage level in the area where the pest is present is medium.

2.2 - How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?

massive

Level of uncertainty: low

Based on the information available regarding significant damage already occurring within the PRA area, the EWG felt that the likelihood of 'massive' negative effects on crop yield was high, and with 'low' uncertainty.
It was noted that recent experiences in North America since 2008 have shown that the impact of *D. suzukii* on local agriculture tends to decrease, although the conditions each year cause variations in populations, increased awareness, improved monitoring, and treatments may have reduced populations (Hueppelsheuser & Hauser, pers. comm., 2010).
The fat that multiple generations are likely to occur in many parts of the PRA area (see figure 9 in Appendix 3) indicates that damage are likely to be high in such conditions. In addition, information from Trentino-Alto Adige region suggests that the species can be abundant even in areas where the degree day accumulations indicate that only one or two generations per year can be completed.

2.3 - How easily can the pest be controlled in the PRA area without phytosanitary measures?

with much difficulty

Level of uncertainty: low

Based on the information available about *D. suzukii* control and the practical difficulties involved, the EWG concluded that without phytosanitary measures, control would be very difficult. Uncertainty was considered low.

Based on experience in areas where *D. suzukii* infestation has resulted in crop damage, control may be feasible, though not necessarily easy. Strategies for control aim to reduce the general *D. suzukii* population by adapting a system based on monitoring, good cultural sanitation, and insecticide use when necessary. Monitoring is key, if any level of control is to be attained in order to control the insect before eggs are laid. Spotted wing drosophilae can be monitored using trapping systems.

There are three component parts to a management program and it is crucial that the timings of these activities are applied in conjunction with the information collected from monitoring activities:

1. ***Sanitation.***

Any fruit that remains in the field or orchard serves as a food source and allows eggs and larvae to fully develop and serves as a fly production source. When feasible, fruit from the crop site should be removed and destroyed either by burial or disposal in a closed container. This will reduce the pest numbers. Composting is not a reliable way to destroy eggs and larvae in fruit.

2. *Area-wide management.*
Management practices carried out over a wide area are essential. Even if precise flight distances are unknown, *D. suzukii* is considered to be able to fly some kilometres within a territory. It is important for every grower within and next to a fly-infested area to participate, because a single, unmanaged field or orchard will serve as a source of infestation to nearby susceptible crops. Attention should also be given to meadows with scattered fruit trees, abandoned orchards and private gardens, all of which provide additional hosts.

3. Plant protection products
Active substances such as organophosphates, pyrethroids, and spinosyns have been shown to be very effective in reducing numbers of *D. suzukii* adults and are expected to give coverage for 7-10 days. As always, plant protection products must be used in line with the instructions on the product label in particular the maximum delays before harvest

The fruit is most susceptible to attack after it has coloured and developed some sugar. If monitoring indicates pest presence at this time, an insecticide spray should be applied to protect the fruit during this time. If monitoring indicates a high population earlier in the season, an earlier spray to reduce populations may be warranted in addition to a pre-harvest application. Post-harvest application to host crops can also be considered to decrease fly numbers.

D. suzukii is often not noticed until fruit is being harvested. Sprays at this time will not protect the crop, because larvae are already in the fruit. There are no effective tools for controlling larvae within the fruit (the eggs are laid in the fruit so the larvae are never found outside the fruit).

2.4 - How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?

moderate

Level of uncertainty: high

The EWG was confident that increased associated costs would be incurred at least in the first years of infestations, but given the inexperience with the pest the level of uncertainty was considered high. Costs will be incurred for labour and materials associated with monitoring, sanitation management, and additional targeted applications of plant protection products. Due to limited experience in areas experiencing *D. suzukii* infestations, there is some uncertainty regarding exactly how expensive control and management strategies may be. Optimal control management strategies are yet to be well defined and these may or may not incur increased costs in terms of chemical use and/or labour.

Experience and associated costs of *D. suzukii* control to date: British Columbia (Hueppelsheuser, pers. comm., 2010):
From limited experience of *D. suzukii* control in berry crops in British Columbia, it is estimated that some 1-3 insecticide sprays, i.e. 1-2 spring and/or pre-harvest sprays, and 1 post harvest spray will be required (although this has yet to be demonstrated in a full season of *D. suzukii* exposure). To some extent, *D. suzukii* numbers may be suppressed in conventional agricultural systems in which growers already use some relevant insecticides (e.g. cherries, managed for Cherry fruit fly (*Rhagoletis* spp.)). Many growers in North America use GF-120, a commercial attract-and-kill product that has been shown to kill *D. suzukii* but is not effective in reducing the fly population. Cherry growers therefore need to ensure some broadcast canopy sprays are integrated into their rotation, based on fly trapping information. In this case, there will not necessarily be more insecticide applications, though they are likely to be different. Therefore increase in control costs for cherry is limited.
There may be costs associated with obtaining registrations for important plant protection products. British Columbia for example has emergency registrations for malathion, cypermethrin, spinatoram, and spinosad for berries, stone fruit, and grapes for *D. suzukii* in 2010, though many of these products were already registered for at least some fruit

crops for other pests.
Associated costs of trapping: BC currently has some 4 trapping projects, hiring about 7 summer students, plus support activities from the provincial and federal government (insect identification, laboratory space, vehicles, supervision). The projects are funded by a combination of grower organization research and development funding and government funds. Cost for supplies: some 600 traps have been placed, costing $1.5 each, plus the cost of bait solution (yeast+sugar or cider vinegar 1-2 oz per trap; cost for the whole season has yet to be calculated). Some of the projects are expected to continue, albeit refined, though this is not yet certain. Additionally, private consultants are also trapping so there is some cost being borne by the growers themselves.

2.5 - How great a reduction in consumer demand is the pest likely to cause in the PRA area?

moderate
Level of uncertainty: high

There are no direct indications that *D. suzukii* would reduce consumer demands. However, the EWG did identify several issues that could potentially be of relevance:

- If it was demonstrated that control required increased use of plant protection products, then potentially there could be issues of public sensitivity and concerns.
- Potential reduction in demand due to increased cost of product. The EWG felt that most of the fruits e.g. berries, are seen as luxury items and consumers could more easily stop consumption. Another associated issue regarding cost could be buyer competition i.e. advantages to wholesalers with knowledge of infested areas.
- Consumer buying infested fruits are likely to switch to other products.
- The public may perceive the fruit to be less hygienic once they know more about the pest. Particularly (in English), the use of the term 'maggots' for the larvae tends to be particularly off-putting.

The EWG based the decision on experiences in North America in which there had been no noticeable reduction in consumer demand, though, based on the above points, there is scope for concern, denoting as uncertainty level of 'medium'.

2.6 - How important is environmental damage caused by the pest within its current area of distribution?

minor
Level of uncertainty: medium

As far as is known, there are no specific records referring to environmental damage caused by *D. suzukii*. For control, there is likely to be an increased reliance on insecticides on crops, though, as long as the products are used within the approved restrictions for use and label directions there should not be direct environmental consequences. However, consideration should be given for each local cropping system and IPM strategies, including impacts on beneficial insects.
Uncertainty: *D. suzukii* has a wide host range and might also attack certain tree and shrub species grown in public and private areas and may consequently have an environmental impact but this is very speculative.

2.7 - How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?

minor
Level of uncertainty: medium

In general, newly established species may change competition dynamics, reduce biodiversity, and disrupt ecosystems. In the EPPO region, *D. suzukii* has so far been detected in 'natural' areas where, theoretically this could occur. To date there have been no observed impacts.
Uncertainty: The EWG acknowledged that impacts could be perceived such as reduction of natural fruit resources for birds and impacts on seed dispersal but no information is available so far.

2.8 - How important is social damage caused by the pest within its current area of distribution?

minimal
Level of uncertainty: low

No social impact is recorded.

2.9 - How important is the social damage likely to be in the PRA area?

minor

Level of uncertainty: medium

Social damage is not presumed to be higher than in the area of origin. However, the EWG felt that there could be an effect on wild fruit picking which is socially important in parts of the region. This may be the case especially for blueberries which are collected from the wild by private persons to a big extent (although this is dependant from local legislation picking fruits in the wild may not be allowed).

2.10 - How likely is the presence of the pest in the PRA area to cause losses in export markets?

Moderately likely

Level of uncertainty: medium

In Canada *Drosophila suzukii* is not currently regulated, though a recent pest categorization has determined that it meets the official definition of a quarantine pest by IPPC criteria (Damus, 2010). It has been declared a quarantine pest by New Zealand (Anonymous, 2009). It is unlikely to be declared a quarantine pest in the United States and the state of California has announced it will not undertake control or regulatory actions on this fly (Damus, 2010) mainly because of the rapid spread of the pest.

In Australia, cherry import from the USA is currently regulated under Public Quarantine Alert PQA0665 (effective from 18 May 2010), requiring consignments to be subject to pre-export fumigation and sampling. See:
http://www.aqis.gov.au/icon32/asp/ex_topiccontent.asp?TopicType=Quarantine+Alert&TopicID=23069

A draft PRA has recently been published and recommendations for import regulation are made.

D. suzukii is not known to be regulated elsewhere, and therefore it is unlikely that under the current regulatory status that there will be losses to export markets. In addition, the trade volume of relevant fruit commodities outside Europe is low (EUROSTATS consulted for the export from European countries in 2008 and 2009 to Australia for various host fruits very limited exports recorded, few 41 T of Grapes in 2008 and 94 T of small fruits).

The main potential risk of losses of export market is if countries in the EPPO region establish restrictions to protect their fruit production and then this could affect the countries where the pest is present. This has no happened so far although the pest is recorded since 2009.

As the responses to question 2.2 was ""massive" and the answer to 2.3 was "with much difficulty" the EWG considered that there was no need to examine the other questions of this section.

2.16 – Conclusion of the assessment of economic consequences :

The EWG concluded that the potential for economic consequences due to *D. suzukii* incursions were 'high', with 'low' uncertainty.

The strongest factor determining this decision was the fact that there is already evidence of extremely high crop yield losses where this pest establishes. Notwithstanding that there are some uncertainties:

- limited information regarding damage in Asia although it is suspected that susceptible crops are not widely grown.
- uncertainty regarding whether establishment will be possible, for example, in Northern Europe.
- The potential economic costs associated with control and management.

Despite the above uncertainties, the EWG was confident that when establishment occurs, damage is almost certainly going to be high initially. Management and experience, or even the fact that growers could change their agricultural systems and grow different crops altogether, may well reduce damage levels in the future.

An additional consideration was that the EWG did not consider that grapes could be regarded to be a major host. However, there is some uncertainty over this point and the possibility of infestation potential could not be ruled out. In such case the potential for economic damage in the region is higher.

Identify the parts of the PRA area where the pest can establish and which are economically most at risk.

The part of the PRA area where damage can occur is the whole PRA area except the northern areas of Europe and northern parts of Russia where climatic conditions are not suitable. Damage will be maximum where the climatic conditions are optimal.

Stage 2: Pest Risk Assessment - Section B : Degree of uncertainty and Conclusion of the pest risk assessment

2.17 - Degree of uncertainty : list of sources of uncertainty

Major uncertainties are

- Whether grapes could be regarded to be a major host. In such case the possibility of infestation potential could not be ruled out. This is likely to be determined by skin thickness, i.e. the variety.
- Whether establishment will be possible in some parts of the PRA area, for example, in Northern Europe.
- The potential economic costs associated with control and management
- Little information regarding damage in China (but this is often difficult to access information from China)
- Rate of natural spread

Other uncertainties

- Transfer from fruits to host plants (this is a very common uncertainty for transfer from fruits to host plants and as the pest has been found in invaded areas in crops transfer is possible)
- Concentration of the pest on the fruits (has an influence on the risk of entry but the pest has already entered so this uncertainty is less important)
- Importance of social and environmental damage

2.18 - Conclusion of the pest risk assessment

The pest is capable of establishing in the region and can cause economic damage (damage is noted already in the PRA area). The experience in North America and also France shows that the pest is able of very rapid spread.

Stage 3: Pest Risk Management

3.1 - Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?

From the pest risk assessment it can be concluded that the pest presents the characteristics of a quarantine pest. However the rapid spread (combination of natural and human spread), makes its regulation difficult and movement of fruits of hosts of *D. suzukii* is at present not restricted for at least countries of the European Union. Nevertheless such regulation is possible and the EWG considered that management measures should be identified so that EPPO member countries could consider including measures in their regulations.

Little time was spend on the management section as the EWG considered that the most urgent output of the meeting should be the rapid delivery of a factsheet providing information on control measures in the crops to deal with the outbreak currently occurring.

3.2 - Is the pathway that is being considered a commodity of plants and plant products? **yes**

3.12 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the box notes)

no

The information presented below is based on the information available at the EPPO Secretariat on phytosanitary regulations of member countries .

In EU countries and countries with EU like legislation a phytosanitary certificate is not required for the importation of *Rubus* fruits. A Phytosanitary certificate is required for fruits of *Prunus*, and *Vaccinium* but no specific requirements that would be appropriate for *D. suzukii* are in place.

For North African countries no specific measures seem to be required (Morocco has requirements for *Prunus* fruits but these target a fungi *Monilinia fructicola* so they are not appropriate, Algeria requirements for the genus Prunus but targeting *Quadraspidiotus perniciosus,* no specific requirements found for Tunisia).

For Israel, import of fruits of Rubus is authorised from European countries only but no specific requirements that would be appropriate for *D. suzukii* are in place. For other fruits an import permit is required (Ministry of Agriculture and rural development, Plant Import Regulation, 2009).

For Turkey requirements exist for *Prunus* fruits but these target a fungus *Monilinia fructicola* so they are not appropriate.

No specific requirements could be identified in the legislation of Russia or other CIS countries available at EPPO.

3.13 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?

yes in combination

possible measure in a SA: visual inspection.

As explained in question 1.9 early infestations are difficult to detect nevertheless it also depends on the hosts. On cherries or *Vaccinium* infested fruits show small scars and indented soft spots on the fruit surface left by the females ovipositor ("stinger") (Dreves *et al.* 2009). Nevertheless similar symptoms can have other cause fruits should be cut open.

On other fruits (*Rubus* spp, *Fragaria, Prunus*) infestation is more difficult to detect due to the uneven or hairy surface. Eggs and respiratory tubes will be difficult to see.

It is not clear whether a flotation system would be effective for the detection of infested fruits.

Visual inspection should not be recommended as a sole measure but more for the verification of another measure.

3.14 - Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)? **no**

3.15 - Can the pest be reliably detected during post-entry quarantine? **no** (not practical for fruits)

3.16 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?

Yes (experimental data available for Cherry fruits)
possible measure: specified treatment.

Chemical treatments:
There are no chemical treatments for controlling larvae within the fruit (the eggs are laid in the fruit so the larvae are never found outside the fruit).

Cold treatment:
For cherries cold treatment is possible provided that fruits are kept 96 hours continuously at 1.66 degrees (Kanzawa, 1939). For other fruits no information is available. **It should be noted that these are laboratory results which have not been verified in commercial consignment conditions.** In addition small fruits are usually traded quickly as they do not keep for long periods which is unlikely to be compatible with the duration mentioned for cherry.

Other treatments
Controlled atmosphere should be investigated but no data is available for the moment for *D. suzukii*.

There is no information on the efficacy of irradiation on *D. suzukii.* Information on to what extent irradiation is used in EPPO countries was not available to the EWG. In the EU, few countries allow the irradiation of fruits (see the list of Member States' authorisations of food and food ingredients which may be treated with ionising radiation (2009/C 283/02). In addition the treatment, should be conducted in an approved irradiation facility (see Commission Decision of 7 October 2004) so irradiation is not a feasible measure for all EU trading partners. As irradiation only sterilize insects and does not kill them, presence of living insects remains a concern for some countries.

3.17 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? **no**

3.18 - Can infestation of the consignment be reliably prevented by handling and packing methods?

yes
possible measure in a SA: specific handling/packing methods

Handling and packing of fruits include sorting of damaged fruits; Visual inspection during the packing process is possible as well as sorting of soft fruits in cold water bath. However this should be used as a confirmation of other measures.

3.19 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?

yes
possible measure: import under special licence/permit and specified restrictions

Processing the fruits will eliminate the pest but it must be guaranteed that the pest cannot escape from the processing plant and that wastes are strictly controlled. Transport from the entry point to the processing plant should also ensure that the pest cannot escape. The Panel on Phytosanitary Measures considered that such measures should be only allowed on a case by case basis and data should be provided by the company requesting such imports.

3.20 - Can infestation of the commodity be reliably prevented by treatment of the crop?

yes
possible measure in a SA: specified treatment and/or period of treatment

Treatment is possible but should not be used as a single measure.

Treatment of the crop is possible but it should be based on the results of monitoring. The most efficient method for early detection is by trapping. Active substances such as organophosphates, pyrethroids, and spinosyns have been shown to be very effective in reducing numbers of *D. suzukii* adults and are expected to give coverage for 7-10 days. However, management practices carried out over a wide area are essential. *D. suzukii* is able to fly some kilometres within a territory. **It is important for every grower within and next to a fly-infested area to participate, because a single, unmanaged field or orchard will serve as a source of infestation to nearby susceptible crops.**

D. suzukii is often not noticed until fruit is being harvested. Sprays at this time will not protect the crop, because larvae are already in the fruit.

3.21 - Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants) **no**

3.22 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?

yes

possible measure: specified growing conditions

For some of the crops (e.g. mainly small fruit production), the plants can be grown under nets with a special mesh size (0,98 mm) (Kawaze & Uchino, 2005). Traps should be placed to control any possible infestation.

3.23 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages? **no**

3.24 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)? **no**

3.27 - The pest has a medium to high capacity for natural spread

Possible measure: pest-free area.

3.28 - Can pest freedom of the crop, place of production or an area be reliably guaranteed? **yes**

The expert working group considered that a pest free place of production can only be guaranteed with physical protection (see question 3.22). Given the spread capacity a pest free place of production will be difficult to maintain in an infested area without physical protection (see also the comment on the necessity to have an area wide management of the pest in question 3.20).

Consequently pest free area only (following ISPM no. 4) was considered as a possible measure.

3.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts? **no**

Surveillance will be difficult as the pest is not easy to detect.

As explained in question 1.21 in a small and restricted area (like a valley) with low abundance and well implemented measures there is a chance for eradication. However, considering the life cycle with up to 15 generations (Kanzawa 1935); the fast development time (8 to 14 days in optimal conditions); some 400 eggs laid per female (maximum of 992 eggs/female); duration of oviposition of 55 days (maximum of 99 days) (Kanzawa 1939); and high insect mobility, it is very unlikely that it will be possible to eradicate the pest in a larger infested area without natural barriers.

As explained in question 1.32 movement of the pest with infested fruits will be difficult to control in the PRA area as early infestations are difficult to detect. Determining containment measures will be difficult given that natural spread capacity is undetermined.

3.30 - Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?

The following individual measures have been identified :

- Visual inspection (for certain fruits) as part of a System Approach
- Cold treatment for cherries (with the uncertainty concerning this treatment for commercial consignments)
- Import for processing only on a case by case basis provided that guarantees can be given that escape of flies will be prevented (case by case upon request).
- Specified growing conditions: provided that the host can be grown under protected conditions, the plants should be grown in screened greenhouses (or under a net) with a mesh lower than 0.98 mm. Trapping to verify pest freedom should be performed)
- Treatment of the crop as part of a System Approach
- Pest Free Area (according to ISPM no. 4)

3.31 - Does each of the individual measures identified reduce the risk to an acceptable level? **no**

- Measures not considered sufficient on their own

Visual inspection (for certain fruits)
Treatment of the crop

- Measures that could be sufficient on their own but have limitations

Specified treatment for certain fruits (e.g. cold treatment for cherries) **however such measures have not been verified for commercial consignments.**

Import for processing provided that it can be guaranteed that no escape of flies possible. **The Panel on Phytosanitary Measures considered that such measures should be only allowed on a case by case basis and data should be provided by the company requesting such imports.**

- Measures that are considered sufficient as single measures
    - Specified growing conditions: provided that the host can be grown under protected conditions, the plants should be grown in screened greenhouses (or under a net) with a mesh lower than 0,98 mm. Visual inspection and trapping are verification procedures which can be applied during handling and packing at the place of production.
    - Pest free area

3.32 - For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?

A possible combination of measures in a Systems Approach could be

- Consignment originating from an Area of low pest prevalence
- Surveillance of the crop based on trapping
- Treatments of the crop
- Inspection during packing and handling
- Cold treatment

However the Panel on Phytosanitary measures considered that such combination should only be considered upon request of an exporting country which should then provide the necessary information to allow a proper evaluation of such combination.

3.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.

The trade in the commodities originating from outside the EPPO region is limited so impact on such trade should be minor. However if restrictions are implemented within the EPPO region impact is likely to be high (e.g. for strawberry, cherries..).

3.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.
no elements to answer

3.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences? Yes

- **Measures that are considered sufficient as single measures**

  - Specified growing conditions (growing the plants under a net or in screened greenhouses and trapping to verify pest freedom)
  - Pest Free Area (following ISPM no. 4)

- **Other measures that can be considered on a case by case basis and upon request**
  - Import for processing provided that it can be guaranteed that no escape of flies is possible
  - A possible combination of measures in a systems approach could be
    - Consignment originating from an area of low pest prevalence
    - Surveillance of the crop based on trapping
    - Treatments of the crop
    - Inspection during packing and handling
    - Cold treatment (but see comment just below)
  - Cold treatments for cherry fruits; data are needed for the efficacy on other fruits than cherry and for cherry data on efficacy of the treatment for commercial consignments are lacking.
  - There is no data available for other treatments (controlled atmosphere, irradiation), such treatment can be considered upon request.

3.41 - Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment
1 Fruits of major hosts
2 Fruits of minor hosts
(However measures recommended do not differ)

References

Arakelian (2009) Data sheet on Cherry vinegar fly (Drosophila suzukii). County of Los Angeles (June 2009). Department of Agricultural Commissioner/Weights and Measures. http://www.sepdn.org/DesktopModules/ViewDocument.aspx?DocumentID=3168 (Accessed 2010-12-01).

Ashburner M, Golic K, Hawley, SH (2005) Drosophila: *A Laboratory Handbook*. Cold Spring Harbor Laboratory Press, New York.

Baker RHA 2002. Predicting the limits to the potential distribution of alien crop pests. In: *Invasive Arthropods in Agriculture. Problems and Solutions*, Hallman, G.J. & Schwalbe, C.P. (Eds). pp. 207-241. Science Publishers Inc. Enfield USA.

Baufeld P, Schrader G, Unger JG (2010) The Cherry vinegar fly - Drosophila suzukii - an emerging risk for fruit and wine growing. [German] Journal fur Kulturpflanzen, 62: 5, 183-186.

BCMAL (2009) Spotted Wing Drosophila (Fruit Fly) Pest Alert. December 2009. British Columbia Ministry of Agriculture and Lands. http://www.al.gov.bc.ca/cropprot/swd.htm (Accessed 2010-12-01).

Biosecurity Australia, 2010. Draft pest risk analysis report for *Drosphila suzukii*. http://www.daff.gov.au/__data/assets/pdf_file/0009/1825497/pra-report-drosophila-final.pdf [last accessed 2011-07-07]

Bolda MP, Coates WW, Grant JA, Zalom FG, Van Steenwyk R, Caprile J Flint ML (2009) Spotted Wing Drosophila, Drosophila suzukii: A New Pest in California. http://www.ipm.ucdavis.edu/EXOTIC/drosophila.html [last accessed 2011-07-07]

Bolda MP, Goodhue RE, Zalom FG (2010) Spotted Wing Drosophila: Potential economic impact of a newly established pest. Publication of the Giannini Foundation of Agricultural Economics, University of California. http://www.agecon.ucdavis.edu/extension/update/articles/v13n3_2.pdf [last accessed 2011-07-07]

Bolda MP (2010) UC IPM, Pest Management Guidelines: CANEBERRIES. Publication 3437. University of California Agriculture and Natural Resources, UC Statewide Integrated Pest Management Program
British Columbia. Agriculture and Lands (Canada). Spotted wing drosophila (fruit fly) Pest Alert. http://www.agf.gov.bc.ca/cropprot/swd.htm

Chambre Régionale d'Agriculture (2010) Bulletin de Santé du Végétal Région Corse 5 août 2010. http://www.fredon-corse.com/standalone/2/E0E38vdftK9web9MmzctDu00.pdf [last accessed 2011-07-07]

Coyne JA, Bryant SH, Turelli M (1987) Long-distance migration of Drosophila. 2. Presence in desolate sites and dispersal near a desert oasis. The American Naturalist 129, (6).

Damus M (2009) Some preliminary results from Climex and Maxent distribution modelling of Drosophila suzukii. Version 2 (2009-10-15). http://entomology.oregonstate.edu/sites/default/files/DrosophilaSuzukiiInfestationModel.pdf

Damus M (2010a). Plant Health Risk Assessment: Drosophila suzukii (Matsumura), Spotted wing drosophila. Unpublished, Canadian Food Inspection Agency, 2010.

Damus M (2010b). Spreadsheet of SWD detections. Received from P. Baufeld.

Damus M (2010c) Maxent and Climex modelling of SWD in the EPPO region. Received from P. Baufeld.

Dreves AJ; Walton V, Fisher G (2009) A new pest attacking healthy ripening fruit in Oregon: Spotted wing drosophila, Drosophila suzukii (Matsumura). Oregon State University. Extension Service (October 2009). http://berrygrape.org/files/Dsuzukii_alert.pdf [last accessed 2011-07-07].

EPPO online article (2010) Drosophila suzukii (Diptera: Drosophilidae) Spotted wing drosophila. http://www.eppo.org/QUARANTINE/Alert_List/insects/drosophila_suzukii.htm [last accessed 2011-07-07]

EPPO (2010a) Reporting Service 2010/007. http://archives.eppo.org/EPPOReporting/2010/Rse-1001.pdf [last accessed 2011-07-07]

EPPO (2010b) Reporting Service 2010/112. http://archives.eppo.org/EPPOReporting/2010/Rse-1007.pdf [last accessed 2011-07-07]

EPPO (2010c) Reporting Service 2010/179. http://archives.eppo.org/EPPOReporting/2010/Rse-1010.pdf [last accessed 2011-07-07]

EPPO (2010d) Reporting Service 2010/209. http://archives.eppo.org/EPPOReporting/2010/Rse-1011.pdf [last accessed 2011-07-07]

Eurostat 2007 EU-27 orchard survey http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-09-041/EN/KS-SF-09-041-EN.PDF [last accessed 2011-07-07]

Flower Council of Holland (2009) *Flowers from Holland.* Leiden, NL.

Hauser M, Gaimari S, Damus M (2009) Drosophila suzukii new to North America. Fly Times no. 43, 12-15. Available online: http://www.nadsdiptera.org/News/FlyTimes/issue43.pdf [last accessed 2011-07-07]

Herring P (2009) Asian fly poses new threat to Oregon. Gazette Times article. http://gazettetimes.com/news/local/article_0fa9a958-b960-11de-a140-001cc4c002e0.html [last accessed 2011-07-07]

Hu K, Zhang W-X, Carson HL. 1993. The Drosophilidae (Diptera) of Hainan Island (China). *Pacific Science* **47**(4):319-327.

Johnston S J and Heed WB (1976) Dispersal of Desert-Adapted Drosophila: The Saguaro-Breeding D. nigrospiracula American Society of Naturalists **110**, 629–651

Kaneshiro KY (1983) *Drosophila (Sophophora) suzukii* (Matsumura). *Proceedings of the Hawaian Entomological society* 24 : 179

Kanzawa T (1935) TRANSLATION. Research into the Fruit-fly Drosophila suzukii Matsumura (Preliminary Report). *Yamanashi Prefecture Agricultural Experiment Station Report*.

Kanzawa T (1936) [Studies on Drosophila suzukii Mats]. *Journal of Plant Protection* (Tokyo) **23**(1/3), 66-70 (in Japanese) (abst.).

Kanzawa T (1939) [Studies on Drosophila suzukii Mats]. Kofu, Yamanashi Agric. Exp. Sta., 49 pp (in Japanese) (abst.).
Kikkawa H, Peng FT (1938) Drosophila species of Japan and adjacent localities. *Japanese Journal of Zoology* **7**, 507-552.

Kawase, S. Uchino, K. (2005) Effect of mesh size on Drosophila suzukii adults passing through the mesh. *Annual Report of the Kanto-Tosan Plant Protection Society* **52**,99–101.

Kimura, M. T. (2004) Cold and heat tolerance of drosophilid flies with reference to their latitudinal distributions. *Oecologia*, **140**: 3, 442-449.

Lies M (2009) Tiny fly poses huge threat. http://www.capitalpress.com/content/ml-pest-scare-110609-art [last accessed 2011-07-07]

MacLeod A & Baker RHA (2003) The EPPO pest risk assessment scheme: assigning descriptions to scores for the questions on entry and establishment. *Bulletin OEPP/EPPO bulletin* 33, 313-320.

MAF Biosecurity New Zealand (2009) Import Risk Analysis: Table grapes (Vitis vinifera) from China, 314 pp. http://www.biosecurity.govt.nz/files/regs/imports/risk/table-grapes-china-ra.pdf [last accessed 2011-07-07]

Malguashca F, Ferguson H, Bahder B, Brooks T, O'Neal S, Walsh D (2010) Spotted Wing Drosophila, 4 October 2010 Grape Update: Injured and ripening fruit may Final PRA report for Drosophila suzukii become more attractive: Monitoring strongly recommended. Washington State University Extension. http://extension.wsu.edu/swd/Documents/SWDGrapeUpdate10_4_10.pdf [last accessed 2011-07-07]

Mitsui H, Achterberg K van, Nordlander G, Kimura, MT (2007) Geographical distributions and host associations of larval parasitoids of frugivorous Drosophilidae in Japan. *Journal of Natural History*, **41**: 25/28, 1731-1738.

Mitsui, Hideyuki; Beppu, Katsura; Kimura, Masahito T. (2010) Seasonal life cycles and resource uses of flower- and fruit-feeding drosophilid flies (Diptera: Drosophilidae) in central Japan. *Entomological Science*, **13** (1), 60-67.

Okada T (1964) New and unrecorded species of drosophilidae in the amami islands, Japan. *Kontyu* **32**(1), 105 – 115.

Price JF and Nagle C (2009) New spotted wing Drosophila to attack Florida strawberries. http://strawberry.ifas.ufl.edu/BVT0909.pdf [last accessed 2011-07-07]

Sasaki M, Sato R (1995a) Bionomics of the cherry drosophila, Drosophila suzukii Matsumura (Diptera: Drosophilidae) in Fukushima Prefecture [Honshu]. 1. Drosophila Injured on Cherry Fruit. *Annual Report of the Society of Plant Protection of North Japan* **46**: 164–166.

Sasaki M, Sato R (1995b) Bionomics of the cherry drosophila, Drosophila suzukii Matsumura (Diptera: Drosophilidae) in Fukushima Prefecture [Honshu]. 2. Overwintering and number of generations. *Annual Report of the Society of Plant Protection of North Japan* **46**: 167–169.

Sasaki M, Sato R (1995c) Bionomics of the cherry drosophila, Drosophila suzukii Matsumura (Diptera: Drosophilidae) in Fukushima Prefecture [Honshu]. 3. Life Cycle. *Annual Report of the Society of Plant Protection of North Japan* **46**: 170– 172

Singh BK & Negi NS (1989) Drosophilidae of Garhwal region with the description of one new species. *Proceedings of the Zoological Society of Calcutta* **40**: 21.

Storozhenko SY, Sidorenko VS, Lafer GS, Kholin SK (2003) [The international biodiversity observation year (IBOY): insects of forest ecosystems of the Primorye region]. A. I. Kurentsov's Annual Memorial Meetings 13, 31-52. Available online: http://www.biosoil.ru/kurentsov/13/xiii-02/P-xiii-02.pdf [last accessed 2011-07-07]

Toda MJ (1991) Drosophilidae (Diptera) in Myanmar (Burma) VII. The Drosophila melanogaster species-group, excepting the D. montium species-subgroup. *Oriental Insects* **25**, 69-94.

Uchino K (2005) Distribution and Seasonal Occurrence of Cherry Drosophila Drosophila suzukii Diptera:Drosophilidae injurious to Blueberry in Chiba Prefecture *Annual Report of the Kanto-Tosan Plant Protection Society* **52**: 95–97.

Walsh (2009) Spotted wing drosophila could pose threat of Washington fruit growers. Washington State University Extension. http://sanjuan.wsu.edu/Documents/SWD11.09.pdf [last accessed 2011-07-07]

Appendix 1
Crop hosts with economic damage

Family	Species	Common name	Reference(s)	Region	Information
Ericaceae	*Vaccinium spp*	Blueberry	Arakelian 2009; Dreves *et al*., 2009; Hauser *et al*., 2009;	US (California), Japan, Italy	+++
Rosaceae	*Prunus avium*	Cherry	Kanzawa 1939 Arakelian 2009; Dreves *et al*., 2009; Hauser *et al*., 2009;	US (California), Japan, France	+++
Rosaceae	*Rubus idaeus*	Raspberry	Arakelian 2009; Dreves *et al*., 2009; Hauser *et al*., 2009;	US (California), Italy	+++
Rosaceae	*Rubus spp*	Blackberry species	Hauser *et al.,* 2009; Walsh 2009; Mitsui *et al*., 2010	US (California, Washington); Japan, Italy	+++
Rosaceae	*Fragaria ananassa*	Strawberry	Arakelian 2009; Dreves *et al*., 2009; Hauser *et al*., 2009; Price & Nagle 2009	US (California, Florida), Italy, France	+++
Rosaceae	*Prunus armeniaca*	Apricot	Kanzawa 1939 (droped fruits) Chambre Régionale d'Agriculture (2010)	Japan France (Corsica)	In the US apricot are considered as a less preferred host but the (Coastes,2009) but D. suzukii is reported attacking Apricot in Corsica
Rosaceae	*Prunus domestica*	Plum	Arakelian 2009; Dreves *et al*., 2009; Hauser *et al*., 2009; Kanzawa 1939	US (California), Japan	++
Rosaceae	*Prunus persica*	Peach, nectarine	Kanzawa 1939, Dreves *et al*., 2009; Hauser *et al*., 2009;	US (California), Japan	++
Vitaceae	*Vitis vinifera*	Grape	Kanzawa 1936, 1939; Dreves *et al*., 2009; Hauser *et al*., 2009;	Japan US (Oregon)	+ damage noted in Japan Kanzawa (1939) Kimura (*pers. comm.* 2010) but no noticeable damage in Oregon (Herring, 2009)

Legend for the column information:

+ few reports of damage in the literature

++: some reports in the literature/sometimes infestation is possible.

+++: major host, well supported by recent evidence of substantial infestations.

Other Rosaceous host but little damage reported

Rosaceae	*Prunus buergeriana* Miq.	Shirozakura	(Sasaki & Sato)		Adult flies reared from field collected fruit
Rosaceae	*Prunus caroliniana* Aiton	Sherry laurel	(Triology 2009)		Adults collected in a multi-lure trap set near *Prunus caroliniana* and there are no reports of larvae in fruit. However, the high association of *Drosophila suzukii* with this genus suggests this species is likely to be attacked and it is a suspected host.
Rosaceae	*Prunus donarium Sieber*	Wild cherry	(Kanzawa 1939)		Recorded as a host from whole fruit
Rosaceae	*Prunus japonica Thunb.*	Korean cherry	(Sasaki & Sato 1995c)		Adult flies reared from field collected fruit
Rosaceae	*Prunus mume Siebold & Zucc.*	Asian plum/Japanese apricot	(Hauser & Damus 2009)		Recorded as a host in California
Rosaceae	*Prunus nipponica Matsumura*		(Mitsui *et al.* 2010)		Reared from fallen fruit only. However, the high association of Drosophila suzukii with this genus suggests this species is likely to be attacked and it is a suspected host.
Rosaceae	*Prunus salicina Lindl.*	Japanese plum	(Bolda *et al.* 2009)		Recorded as a host in California
Rosaceae	*Prunus sargentii Rehder*	Sargents cherry	(Kanzawa 1935)		Recorded as a host from whole fruit
Rosaceae	*Prunus serrulata Lindl. var. Spontanea (Maxim.) E.H. Wilson (syn=Prunus jamasakura Siebold ex Koidz.)*	Japanese mountain cherry	(Sasaki & Sato 1995c)		Adult flies reared from field collected fruit
Rosaceae	*Prunus yedoensis Matsum.*	Tokyo cherry	(Sasaki & Sato 1995c)		Adult flies reared from field collected fruit

Other hosts

Family	Species	Common name	Reference(s)	Region	Comment*
Actinidiaceae	*Actinidia arguata*	Hardy kiwi	Dreves *et al*., 2009;	US (Oregon)	
Adoxaceae	*Viburnum dilatatum*	Viburnum	Mitsui *et al*., 2010	Japan	Reared from fallen fruits only
Cornaceae	*Alangium platanifolium*	Dogwood	Mitsui *et al*., 2010	Japan	
Cornaceae	*Cornus controversa*	Giant Dogwood	Mitsui *et al*., 2010	Japan	
Ebenaceae	*Diospyros kaki*	Persimmon	Kanzawa 1939	Japan	Adults have only emerged from fruit that was either split, damaged, dropped or cut (Kanzawa, 1939).
Eleagnaceae	*Eleagnus multiflora*	Silver berry	Kanzawa 1939		
Ericaceae	*Gaultheria adenothrix*		Mitsui *et al*., 2010	Japan	Reared from fallen fruits only
Garryaceae	*Aucuba japonica*	Spotted laurel	Mitsui *et al*., 2010	Japan	Reared from fallen fruits only
Grossulariaceae	*Ribes* spp	Black current, red currant and gooseberry			Although sometime mentioned as a host *Ribes* spp are hosts only when damaged (Damus *pers. comm.,* 2010 cited in Biosecurity Australia, 2010)
Moraceae	*Ficus carica*	Fig	Dreves *et al*., 2009;	US (Oregon)	There are no reports of damage Figs have only been recorded to be attacked when the fruit is over-ripe (*pers. comm.,* Vaughn Walton, OSU 12 October 2010 cited in Biosecurity Australia, 2010)
Moraceae	*Morus bombycis = Morus australis*	Mulberry	Mitsui *et al*., 2010	Japan	Reared from fallen fruits only but other species are hosts in the family.
Moraceae	*Morus alba*	Mulberry	Kanzawa 1939		Adult flies can emerge from whole fruit

Myrtaceae	*Eugenia uniflora*	Surinam cherry	FDACS, 2010	US (Florida)	
Phytolaccaceae	*Phytolacca americana*	American pokeweed	Sasaki & Sato 1995c.	Japan	Adult flies reared from field collected fruit
Rosaceae	*Eriobotrya japonica*	Loquat	Kanzawa 1939	Japan	Only on damaged fruit or cut surfaces
Rosaceae	*Malus domestica*	Apple	Kanzawa, 1939	Japan	Reared from fallen fruits only
Rosaceae	*Prunus nipponica*	Japanese alpine cherry	Mitsui *et al*., 2010	Japan	
Rosaceae	*Pyrus pyrifolia*	Asian Pear	Dreves *et al*., 2009;	US (Oregon)	No details whether already damaged fruits
Styracaceae	*Styrax japonicus*	Styrax	Mitsui *et al*., 2010	Japan	Reared from fallen fruits only
Taxaceae	*Torreya nucifera*	Japanese nutmeg yew	Mitsui *et al*., 2010	Japan	
Rutaceae	*Citrus* x *paradisi*	Grapefruit	(Triology 2010) (Price and Nagle 2009)	US (Florida)°	Recorded from Citrus in Florida. However, it is only recorded from fallen fruit
Solanaceae	*Lycopersicon esculentum* L	Tomatoes	(ODA 2010a) (Kanzawa 1939)		Attacked ripe fruit in the laboratory. Only on cut fruit in Japan
Rutaceae	*Citrus* x *paradisi*	Grapefruit	(Triology 2010) (Price and Nagle 2009)		Recorded from Citrus in Florida. However, it is only recorded from fallen fruit
Rutaceae	*Murraya paniculata (L.) Jack*	Orange Jessamine	(FDACS 2010)		Recorded as a host

Appendix 2

Data for fruit production in the EPPO region (extracted from FAO STATS)

Cherries

countries	2007	2008
Albania	1400	1500
Algeria	2508	2500
Armenia	1400	1400
Austria	148	151
Azerbaijan	1535	1511
Belarus	177	200
Belgium	1200	1200
Bosnia and Herzegovina	5800	5500
Bulgaria	12092	13000
Croatia	3200	3200
Cyprus	232	232
Czech Republic	785	862
Denmark	60	60
Estonia	350	350
France	11148	10752
Georgia	2200	2200
Germany	5443	5449
Greece	10000	10000
Hungary	1711	1711
Israel	300	350
Italy	28868	28900
Jordan	130	130
Latvia	737	224
Lebanon	8100	8100
Lithuania	1515	1141
Luxembourg	120	120
Moldova	2148	2121
Montenegro	700	700
Morocco	1435	1477
Netherlands	700	700
Norway	275	283
Occupied Palestinian Territory	180	180
Poland	10289	9903
Portugal	6400	6400
Romania	7688	7628
Russian Federation	27000	18000
Serbia	9500	9000
Slovakia	115	93
Slovenia	92	92
Spain	32921	32921

countries	2007	2008
Sweden	160	160
Switzerland	460	460
Syrian Arab Republic	13500	13500
The former Yugoslav Republic of Macedonia	1200	1200
Tunisia	80	80
Turkey	34300	59751
Ukraine	13000	12600
United Kingdom	447	447
	265756	280447

Strawberries

countries	2007	2008
Austria	1398	1560
Belarus	7700	7800
Belgium	1300	1300
Bosnia and Herzegovina	1363	1398
Bulgaria	1240	1182
Croatia	305	305
Cyprus	89	89
Czech Republic	2553	2467
Denmark	900	900
Egypt	15059	12458
Estonia	648	648
Finland	3340	3225
France	3266	3021
Georgia	600	600
Germany	13013	13032
Greece	300	300
Hungary	501	501
Ireland	110	110
Israel	600	500
Italy	6033	6409
Jordan	63	133
Kuwait	12	12
Latvia	341	360
Lebanon	260	260
Lithuania	1821	1640
Luxembourg	3	3
Malta	20	20
Moldova	251	256
Morocco	2800	2950
Netherlands	1700	1700
Norway	1523	1549

countries	2007	2008
Occupied Palestinian Territory	180	180
Poland	52309	54160
Portugal	1700	1700
Romania	2826	2591
Russian Federation	33800	23000
Serbia	7829	7923
Slovakia	271	239
Slovenia	108	124
Spain	8550	8550
Sweden	2200	2200
Switzerland	418	418
The former Yugoslav Republic of Macedonia	500	500
Tunisia	350	350
Turkey	12500	11279
Ukraine	8300	8300
United Kingdom	4800	4800
	207760	195010

Raspberries

countries	2007	2008
Austria	174	156
Azerbaijan	2200	2500
Belgium	30	30
Bosnia and Herzegovina	973	928
Bulgaria	1372	1372
Croatia	278	278
Czech Republic	27	29
Denmark	30	30
Estonia	400	400
Finland	424	459
France	1230	1196
Germany	1121	1120
Hungary	1500	1500
Ireland	45	45
Italy	239	239
Latvia	106	104
Lithuania	1141	981
Moldova	225	213
Morocco	16	16
Netherlands	50	50
Norway	282	282
Poland	20604	19971
Romania	200	200

countries	2007	2008
Russian Federation	34000	23500
Serbia	14496	14680
Slovakia	49	52
Slovenia	0	0
Spain	1400	1400
Sweden	130	130
Switzerland	154	154
The former Yugoslav Republic of Macedonia	10	10
Ukraine	6300	6500
United Kingdom	1571	1634
	92784	82167

Blueberries

countries	2007	2008
Denmark	0	0
Germany	1406	1406
Hungary	0	0
Italy	200	200
Lithuania	4966	5000
Morocco	10	10
Netherlands	1000	1000
Norway	22	24
Poland	1954	2256
Romania	600	600
Russian Federation	600	400
Slovenia	0	0
Sweden	4000	4000
Switzerland	0	0
Ukraine	600	600
	17365	17504

Current

countries	2007	2008
Austria	281	229
Azerbaijan	400	400
Belgium	90	90
Bulgaria	90	90
Czech Republic	1233	1286
Denmark	2000	2000
Estonia	1016	1016
Finland	2263	2190
France	2491	2013
Germany	2043	2025

countries	2007	2008
Hungary	2131	2131
Ireland	15	15
Italy	100	100
Latvia	648	909
Moldova	311	295
Netherlands	800	900
Norway	277	279
Poland	45816	43321
Romania	8	8
Russian Federation	67800	46000
Slovakia	655	652
Slovenia	1	1
Sweden	500	500
Switzerland	51	51
The former Yugoslav Republic of Macedonia	10	10
Ukraine	4300	4500
United Kingdom	2553	2529
	139890	115548

Other berries

countries	2007	2008
Armenia	1100	1100
Austria	1000	1000
Azerbaijan	1600	2200
Belgium	100	100
Bosnia and Herzegovina	100	100
Bulgaria	200	200
Croatia	200	200
Czech Republic	700	700
Egypt	110	110
Estonia	1221	1221
Finland	200	200
Georgia	1000	1000
Germany	80	76
Greece	350	350
Ireland	25	25
Israel	600	600
Italy	7400	8000
Jordan	0	0
Latvia	180	180
Lithuania	600	600
Malta	65	65

countries	2007	2008
Morocco	190	190
Netherlands	300	300
Norway	64	51
Poland	7053	6522
Romania	36	36
Russian Federation	1100	800
Serbia	700	700
Slovakia	20	0
Slovenia	31	30
Spain	500	500
Sweden	1000	1000
Switzerland	30	30
Tunisia	20	20
Turkey	7900	7900
Ukraine	500	500
United Kingdom	350	350
	38632	38964

Peaches and nectarines

countries	2007	2008
Albania	900	800
Algeria	16684	15000
Armenia	6100	6100
Austria	197	190
Azerbaijan	2247	2406
Bosnia and Herzegovina	1600	1700
Bulgaria	6241	6000
Croatia	1100	1100
Cyprus	764	764
Czech Republic	1032	948
Egypt	32500	80199
France	15508	15053
Georgia	1600	1600
Germany	105	105
Greece	36900	36900
Hungary	6740	6740
Iraq	3000	3000
Israel	3600	3900
Italy	86017	86062
Jordan	1357	2357
Lebanon	3550	3550
Libyan Arab Jamahiriya	1300	1300
Malta	60	60

countries	2007	2008
Moldova	5807	5641
Montenegro	700	700
Morocco	4992	4900
Occupied Palestinian Territory	260	260
Poland	3310	3176
Portugal	5900	5900
Romania	1785	1610
Russian Federation	9000	6500
Serbia	10000	10000
Slovakia	718	710
Slovenia	513	513
Spain	76966	76966
Switzerland	13	13
Syrian Arab Republic	6660	6660
The former Yugoslav Republic of Macedonia	1300	1300
Tunisia	17000	16800
Turkey	28000	41446
Ukraine	7500	6700
Yemen	1000	1000
	412533	468637

Aricot

countries	2007	2008
Albania	400	400
Algeria	31085	27000
Armenia	6000	5500
Austria	503	492
Azerbaijan	2109	2269
Bosnia and Herzegovina	300	300
Bulgaria	7092	7000
Croatia	600	600
Cyprus	317	323
Czech Republic	1407	1331
Egypt	15278	15585
France	14176	14049
Georgia	300	300
Germany	55	55
Greece	5300	5300
Hungary	5295	5295
Iraq	5000	5000
Israel	2300	1950
Italy	16308	17370

countries	2007	2008
Jordan	898	898
Lebanon	6397	6397
Libyan Arab Jamahiriya	3500	3500
Malta	2	2
Moldova	2088	2013
Morocco	11341	11187
Occupied Palestinian Territory	460	460
Poland	1638	1670
Portugal	600	600
Romania	3314	2931
Russian Federation	18000	12500
Serbia	3500	2500
Slovakia	209	202
Slovenia	28	28
Spain	19413	19413
Switzerland	646	646
Syrian Arab Republic	13664	13664
The former Yugoslav Republic of Macedonia	400	400
Tunisia	8000	8200
Turkey	62000	62500
Ukraine	9500	9400
Yemen	730	730
	282160	271968

Grapes

countries	2007	2008
Albania	7497	8500
Algeria	76754	75000
Armenia	14097	14390
Austria	44202	45622
Azerbaijan	6518	8856
Bahrain	50	50
Belgium	65	50
Bosnia and Herzegovina	5100	5500
Bulgaria	120341	110816
Croatia	32454	33741
Cyprus	8194	8427
Czech Republic	17008	16302
Egypt	149359	153956
France	828885	813496
Georgia	41200	46300
Germany	99702	99700
Greece	80000	80000
Hungary	75260	75260
Iraq	8000	8000
Israel	5500	6000
Italy	756362	770000
Jordan	3089	3110
Kuwait	10	10
Lebanon	13200	13200
Libyan Arab Jamahiriya	8000	8000
Luxembourg	1386	1400
Malta	800	800
Moldova	138266	136474
Montenegro	10000	10000
Morocco	57400	47271
Netherlands	50	50
Occupied Palestinian Territory	7670	7900
Portugal	222600	222700
Qatar	10	10
Romania	187629	194038
Russian Federation	44500	43600
Saudi Arabia	11675	11675
Serbia	63000	66000
Slovakia	11507	9650
Slovenia	16086	16086
Spain	1157853	1200000
Switzerland	14847	14870

Syrian Arab Republic	33360	33360
The former Yugoslav Republic of Macedonia	21312	21676
Tunisia	25000	29000
Turkey	484610	482789
Ukraine	71200	70900
United Arab Emirates	30	30
United Kingdom	700	700
Yemen	12420	13178
	4996765	5040451

Annex 3: Detailed assessment of the climatic suitability of the PRA area for establishment

1. Using climates in the current area of distribution to assess the climatic suitability of the PRA area

1.1 <u>What is the current area of distribution?</u>

The current area of distribution is described in question 7 and mapped in Fig. 1. The distribution includes China, Japan (all major islands), South Korea, Russia (Vladivostok), India, Pakistan, Thailand, Myanmar, USA (California, Oregon, Washington State, Florida, south Carolina and Hawaii[2]), south-western Canada (British Colombia), north-eastern Spain (Catalonia), Costa Rica, Equador France (Corsica, southern and south-eastern coastal areas) and Italy (Trentino in the north and Tuscany in the centre).

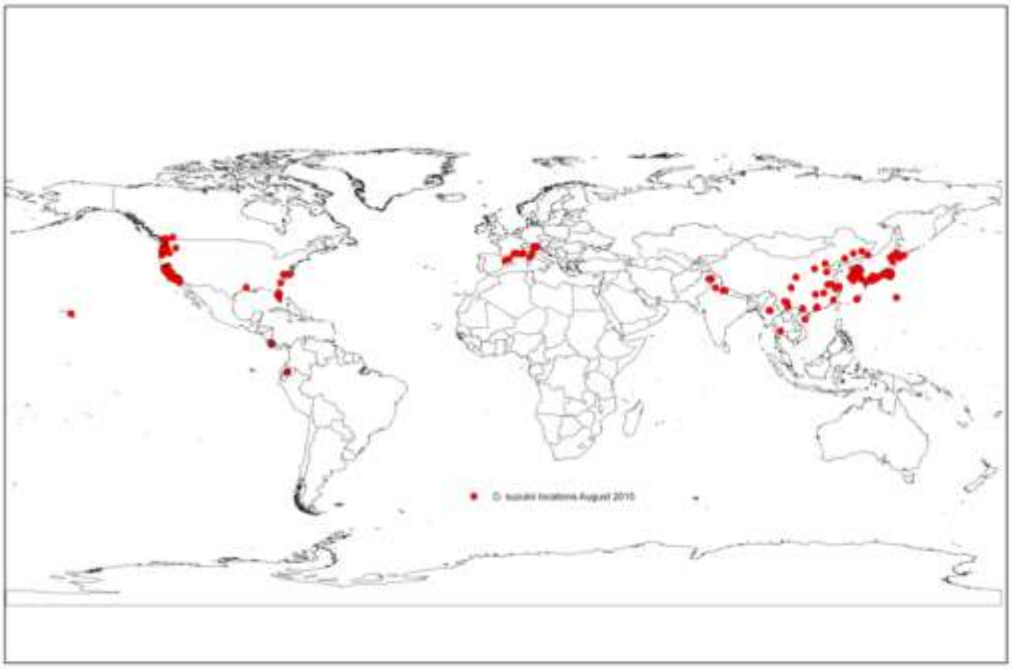


Fig 1 global distribution of Drosophila suzukii (2010-08)

[2] Up to August 2010

1.2 Which *D. suzukii* locations can be used to assess the limits to climatic suitability

Although locations where the pest is present throughout the current species range can be used in climatic suitability assessment, location data are particularly useful from (a) the species' native range and (b) invaded areas where further spread is not considered to be occurring. This is because locations in these areas are more likely to represent the climatic limits to the potential distribution than invaded areas where the species is still spreading and, in addition, records of species absence can be taken into account in the assessment.

For *D. suzukii*, however, the native range is uncertain. Kimura (pers. comm.) considers it to be eastern Asia including China, Japan and Korea. In China the distribution is mainly limited to provincial records (Hu et al., 1993). The 20 provinces listed (mainly by Hu et al., 1993) include the very northern provinces of Heilongjang, Jilin and Liaoning which have very cold winter temperatures. However, there is no additional information that indicates where it is common or at the edge of its range. It is present throughout South Korea. Although there are no records from North Korea, it can be presumed to be present.

In Japan it was first recorded in 1916 (Kanzawa, 1935). Although there is a possibility that an invasion from the mainland may have occurred,, it is now found on all the major islands and can be considered to be no longer spreading. Nevertheless, the degree to which the most northerly locations represent the coolest conditions suitable for *D. suzukii* establishment cannot be determined because these locations are on an island (Hokkaido) with no further prospects for spread to cooler areas. In Hokkaido it is widespread, especially in the autumn, and has 2-3 generations per year (Kimura, pers. comm.). Apart from Hokkaido and the provincial records from China, locations in Russia (Vladivostok), British Colombia and northern Italy (Trentino) represent the most northerly and the coolest conditions where the pest is known to be established. The records from south-east Asia, southern Japan, Costa Rica and Florida, are most clearly representative of the hottest conditions where *D. suzukii* is present. In India and Pakistan, the species only occurs in northern mountainous areas. Biosecurity Australia (2010) summarises reports that confirm that its in ability to tolerate low humidities at high temperatures.

1.3 What climates occur in the pest's current area of distribution?

1.3.1 *Köppen-Geiger climate zones*

D. suzukii occurs in 13 Köppen-Geiger climate zones (see Table 1). These climate zones cover almost all the global land surface except for areas that are arid or very cold (see Fig. 2).

Köppen-Geiger climate zones				**Areas where D. suzukii is present**			
Code	**Main Climate**	**Precipitation**	**Temperatures**	**Asia**	**Japan**	**N. America**	**EU**
Af	Equatorial	Fully Humid				Florida	
Am	Equatorial	Monsoonal				Florida	
Aw	Equatorial	Winter dry		Thailand, Burma, Taiwan, Hainan (China)		Florida	
Cfa	Warm temperate	fully humid	hot summer	Eastern & central China	Rest of Japan		
Cfb	Warm temperate	fully humid	warm summer	NW India		British Columbia	N. Italy
Csa	Warm	dry summer	hot summer			California	Spain, S.

	temperate						France, S. Italy
Csb	Warm temperate	Steppe	warm summer			British Columbia, western USA	SE France, Corsica
Cwa	Warm temperate	desert	hot summer	Northern & western China, Burma, N. India			
Cwb	Warm temperate	desert	warm summer	South-western China			
Dfb	Snow	fully humid	warm summer		Hokkaido	British Columbia	N. Italy
Dfc	Snow	fully humid	cool summer		NE Hokkaido		N. Italy
Dwa	Snow	desert	hot summer	NE China, S. Korea			
Dwb	Snow	desert	warm summer	Extreme NE and desert areas of China, SE Russia			

Table 1 The Köppen-Geiger climate zones where *D. suzukii* occurs

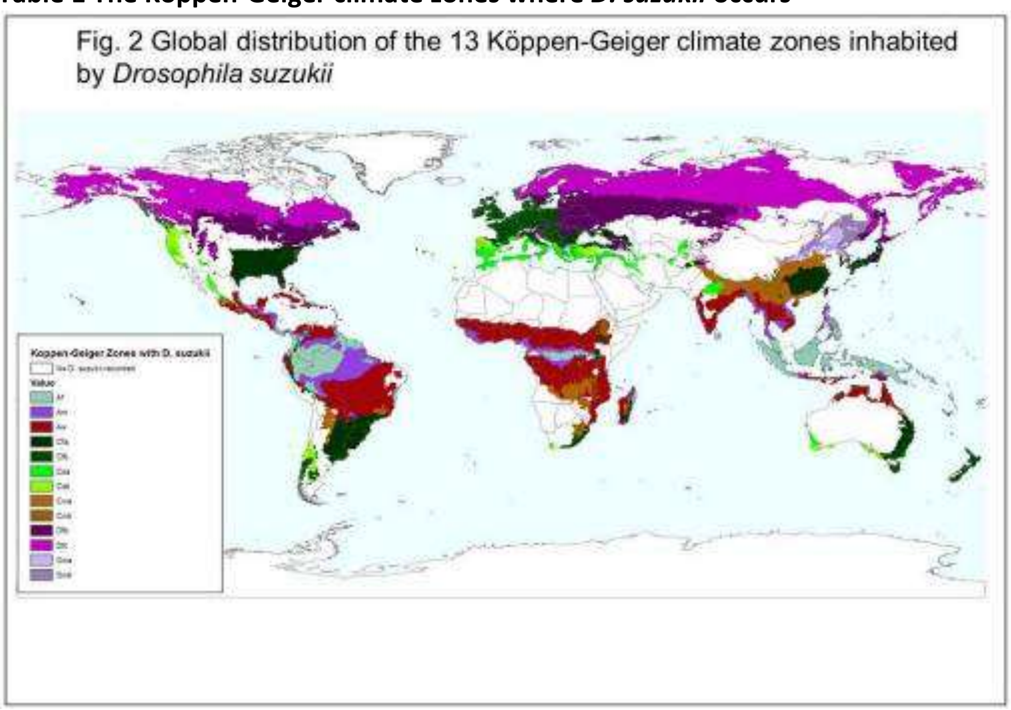


Fig. 2 Global distribution of the 13 Köppen-Geiger climate zones inhabited by *Drosophila suzukii*

Its northernmost limits are currently in areas where very cold winters followed by cool, warm or hot summers are experienced (Dfb, Dfc, Dwa and Dwb). It is also found in areas where there are warm temperate winters and in equatorial climates where there is little temperature seasonality. Summer temperatures where this species is found are generally warm or hot. It is present in a zone with a cool summer (Dfc) in Hokkaido, northern Italy and British Colombia but these grid cells are close to cells with a warm summer (Dfb) and, even in zones with a cool summer, the species may exist in small localized areas with warm summers by exploiting warmer local climates, e.g. on south facing slopes. Warm summers are defined as areas where the threshold is greater than or equal to 10°C for four months. Cool summers occur where this threshold is not reached.

1.3.2 *Hardiness zones*

The Köppen-Geiger climate zones combine winter and summer temperatures. For a separate exploration of the relationship between *D. suzukii* distribution and the severity of winter temperatures, maps of hardiness zones can be used (see Figs 3, 4 & 5). The northerly limit to its distribution in eastern Asia, is primarily in hardiness zone 4 (-35°C) (see Fig. 3). Although Vladivostok and some parts of Hokkaido are in hardiness zone 3, local climate variability and warmer winter temperatures in urban areas, e.g. Vladivostok, may prevent the extreme minimum temperatures (-40°C) of zone 3 from occurring in the habitats used by *D. suzukii* for overwintering. In British Colombia and Trentino-Alto Adige region (northern Italy) the locations are generally in zones 6-7.

Fig. 3 Global map of hardiness zones

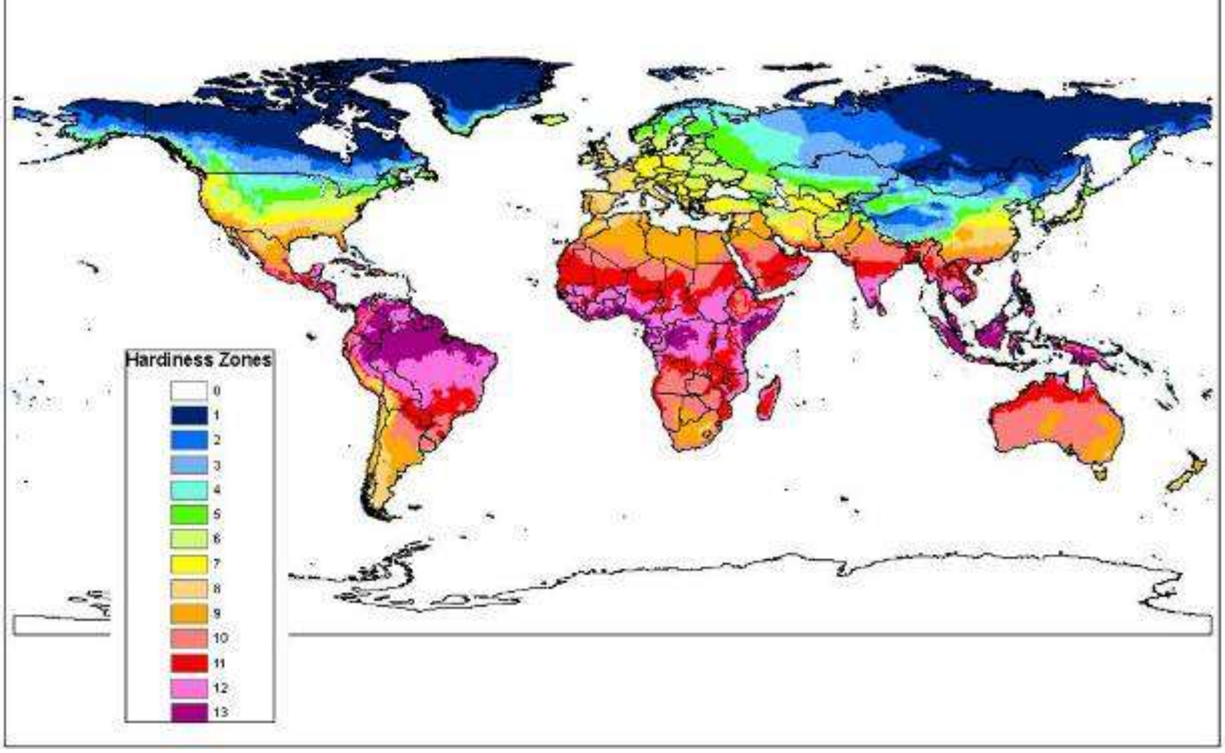


Fig. 4 Hardiness zones in eastern Asia

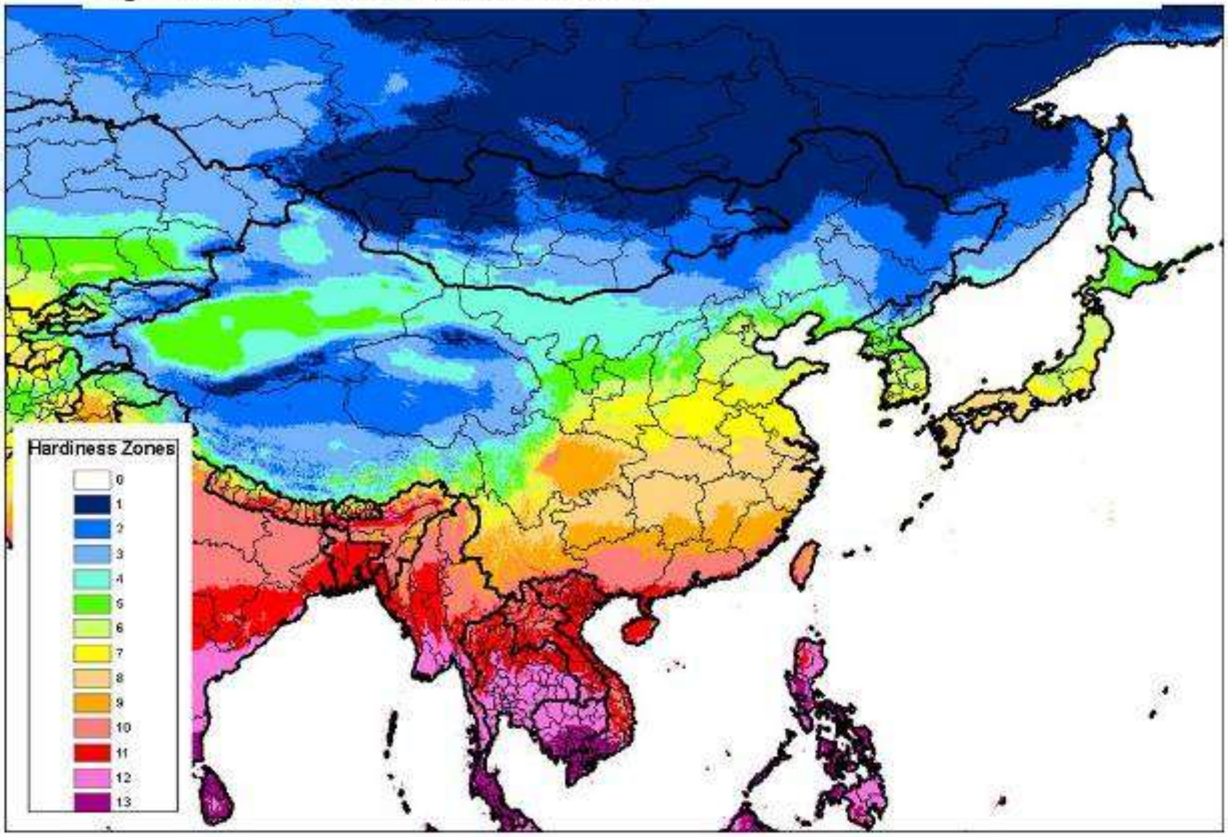
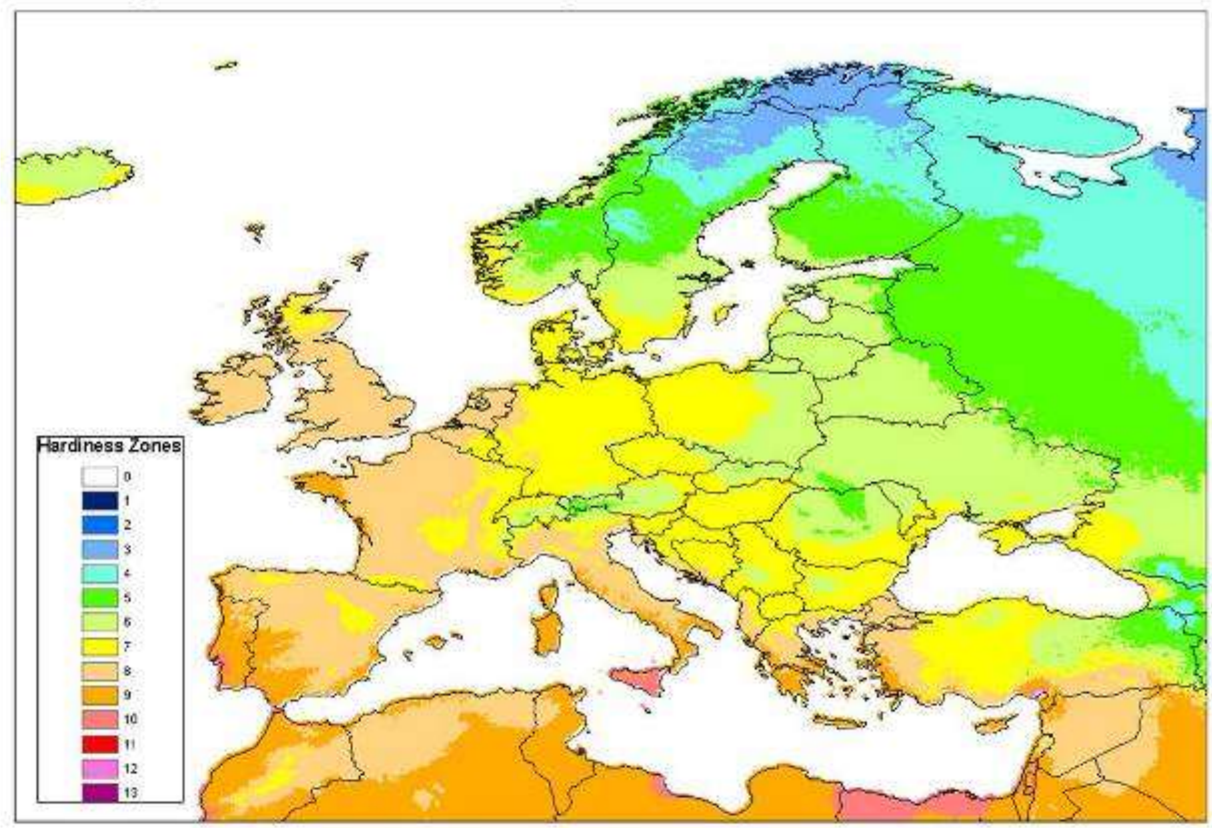


Fig. 5 Hardiness zones in Europe



1.3.3 *Annual Degree Days*

Maps of the annual degree day accumulation above a base temperature of 10ºC (see Figs 6-9) provide a useful method for comparing the distribution of *D. suzukii* with the summer temperatures available for reproduction and development. The majority of the island of Hokkaido has an annual degree day budget of over 500 degree days above a base 10ºC. Most locations where *D. suzukii* is found in Asia, e.g. Russia (Vladivostok) and North America (British Colombia), have annual degree days above this threshold (see Figs 10-11). In areas with hot summers, e.g. southern Italy, annual degree days can exceed 2,000 base 10ºC.

Fig. 6 Global map of annual degree day accumulation above a base temperature of 10ºC

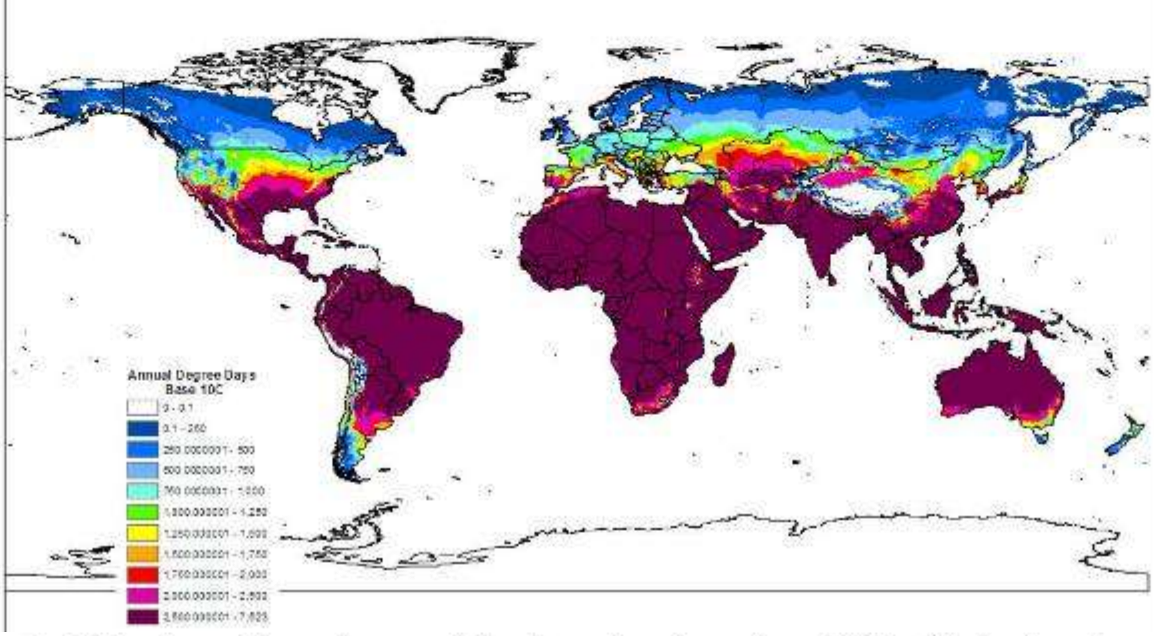


Fig. 7 Map of annual degree day accumulation above a base temperature of 10ºC and the locations of *Drosophila suzukii* in Eastern Asia

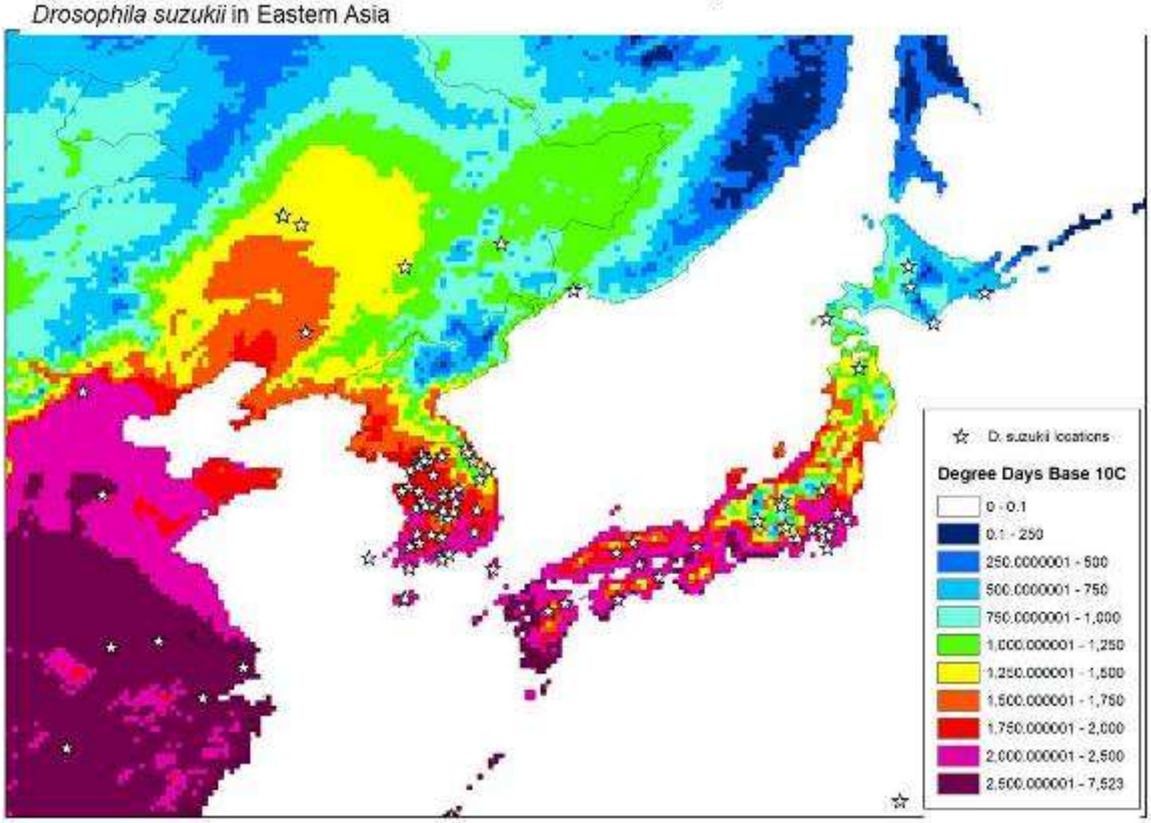


Fig. 8 Map of annual degree day accumulation above a base temperature of 10°C and the locations of *Drosophila suzukii* in Western North America

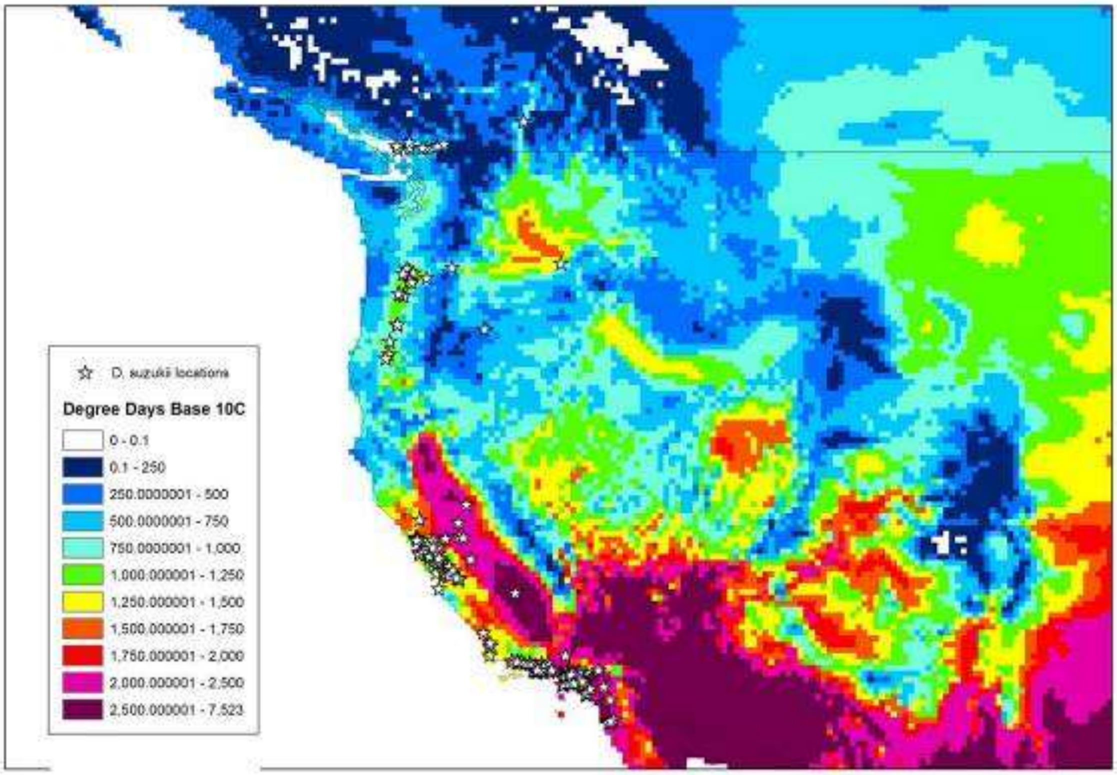
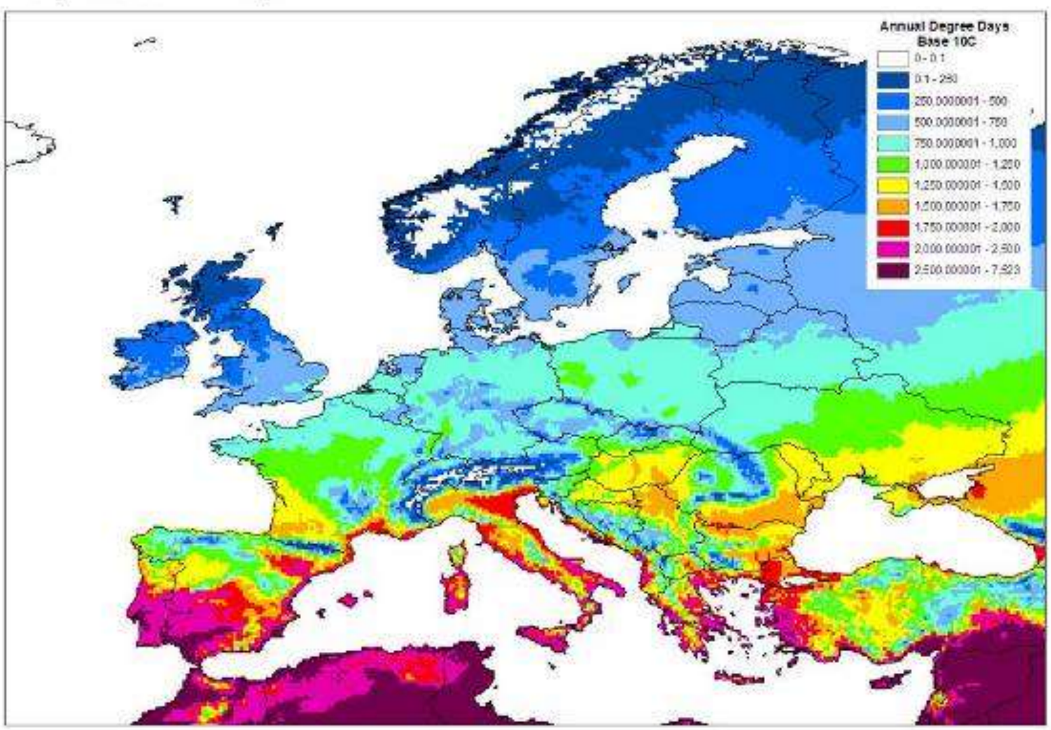


Fig. 9 Map of annual degree day accumulation above a base temperature of 10°C and the locations of *Drosophila suzukii* in Europe



Note that the key is in multiples of 250°C so it allows to visualize areas where the number of generations will be higher although it should be noted that the species does not tolerate high temperature if humidity is low

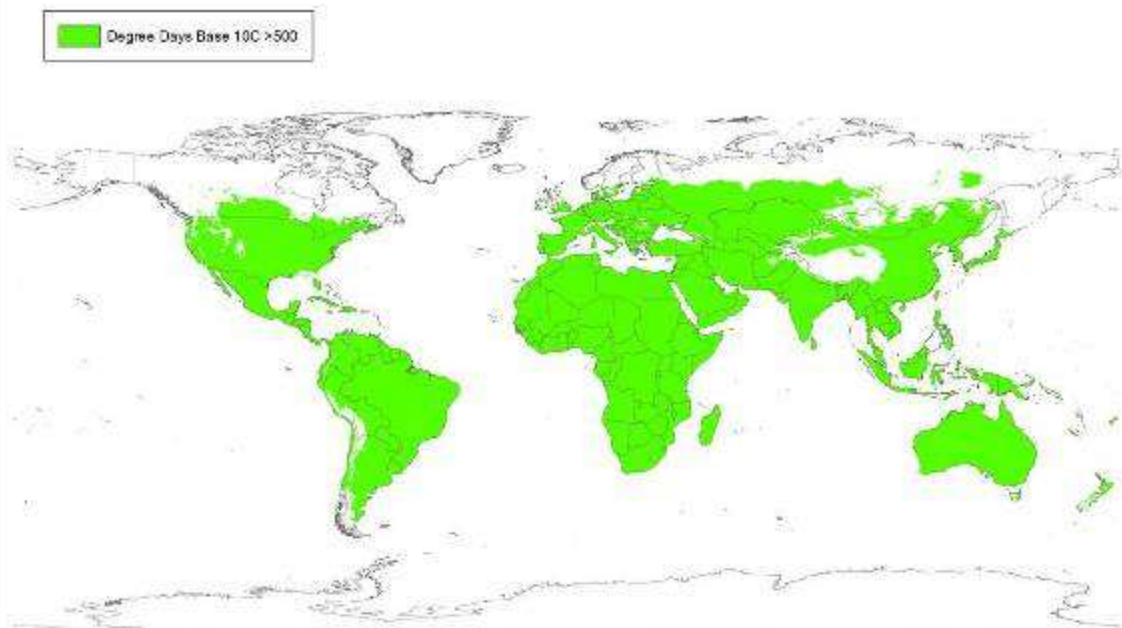
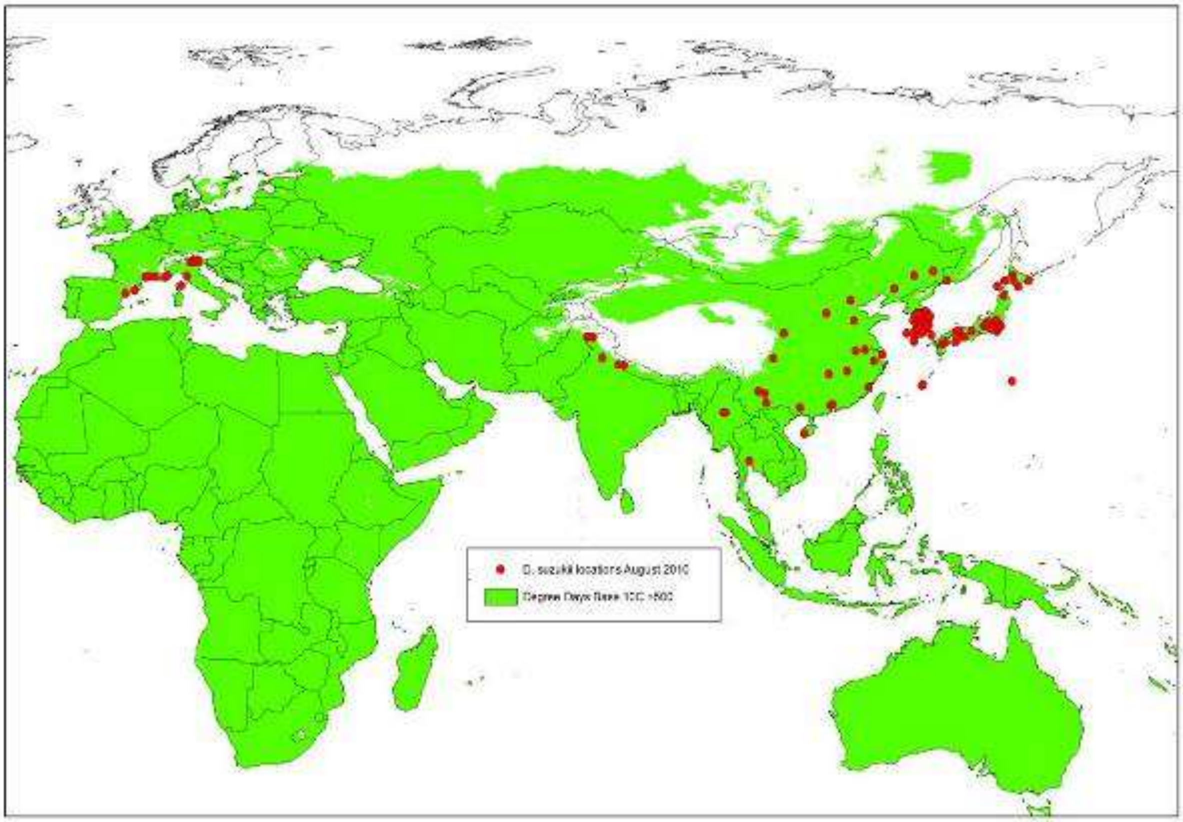


Fig. 10 Global map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 500

Fig. 11 Map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 500 in Europe and Asia



1.4 <u>Where in the PRA area are there hosts and/or suitable habitats?</u>

Potential wild and cultivated hosts are very widespread in the region except in extremely cold areas at high altitudes and latitudes and in the arid regions of Asia (see question 1.16)

1.5 <u>What climates in the pest's current area of distribution occur in the PRA area where there are suitable hosts/ habitats?</u>

Apart from the extreme north and at very high altitudes, only one of the Köppen-Geiger climate zones in Europe has not been colonized by *D. suzukii* anywhere in the world. This is the arid zone Bsk (with steppe precipitation and cold arid temperatures) and is primarily found in Spain.

Due to the influence of the gulf stream, in Europe, apart from at high altitude in the Alps and Carpathians, hardiness zone 4 is restricted to central and northern Norway and Sweden, Finland (except for the southern coastline), Russia and areas in other countries close to Russia's western border (see Fig. 4). Everywhere else has less severe hardiness zones.

In Europe, areas where the 500 degree days base 10°C threshold is exceeded are found in all countries, though they are limited to southern areas of Norway, Sweden, Finland, Ireland and the UK (Fig. 5).

1.6 <u>Conclusions on the climatic suitability of the PRA area based on the climates in its current area of distribution</u>

The climate in the PRA area is largely similar to its current area of distribution since *D. suzukii*:

- has colonised almost all the Köppen-Geiger climate zones that occur Europe
- is present in all but the coldest and driest world hardiness zones found in Europe
- has been recorded in areas with an annual degree day budget greater than or equal to 500 in all except northern

regions of the PRA area.

2. Using the known climate response data for *D. suzukii* to assess the climatic suitability of the PRA area

2.1 The minimum threshold for development

The minimum threshold for development is considered to be 10ºC with an egg to adult development time of 254 degree days by Coop (unpublished) who analysed development data from Kanzawa (1936 & 1939) and Sakai and Sato (1996). The 254 degree days required for development is supported by Uchino (2005) who calculated that D. suzukii needed 250 days for development at Chiba (near Tokyo) in 2003. The studies by Kanzawa (1939) were based on only two temperatures (15ºC and 25ºC) and with only 10 individuals at 15ºC and 7 individuals at 25ºC. The Sakai and Sato (1996) paper has not been obtained and so we cannot verify the experimental conditions or confirm whether the experiments were actually undertaken on *D. suzukii* (the paper is apparently based on *D. pulchrella*, a very closely related species). Damus (unpublished) used 9.1ºC for the minimum threshold for development and 268 days for the completion of development Kimura (pers. comm.) confirms that a base temperature of 10ºC with an egg to adult development time of 250 degree days is appropriate for *D. suzukii*.

2.2 Maximum temperature limits

Adult activity is reduced above 30ºC (Kanzawa, 1939) but the effect of high temperatures on development is poorly known. Damus (unpublished) used a higher development threshold of 32ºC. *D. suzukii* is known to move to higher altitudes in summer but this is to take advantage of additional resources rather than an avoidance of summer heat (Mitsui *et al.*, 2010). Kimura (2004) found that the lethal hot temperature (LT) that killed 25, 50 and 75% of the population following the 24 hour exposure of male and female *D. suzukii* was between 31.6ºC and 32.9ºC. Smyth (pers. comm.) found that at 32 ºC adults cannot emerge from pupae and males become sterile and that adults die after 3 hours of exposure to temperatures higher than 35 ºC.

2.3 Minimum temperature limits

Below 5ºC adults are motionless (Kanzawa, 1939). Kimura (2004) found that the lethal cold temperature (LT) that killed 25, 50 and 75% of the population following the 24 hour exposure for male and female *D. suzukii* was between -1.6ºC and 0.5ºC. However, it is difficult to extrapolate these data to an assessment of overwintering because insect cold tolerance is known to be highly dependent on the temperature conditions exposed to insects prior to the experiment and the rate of cooling (Leather et al, 1993)). Kimura (pers. comm.) considers that in Hokkaido, the severe winter causes high mortality but that the population survives in habitats associated with human habitation and is augmented by entry with fruit imports from elsewhere in Japan.

2.4 Phenology model

Since *D. suzukii* can survive the very cold winters at its northern limits to its distribution in Asia, such severe winters occur very rarely in Europe and hosts are very widespread the principal factor determining its northerly limits in Europe is likely to be the amount of degree days available for development and reproduction. A simple phenology model with a base temperature of 10ºC and 250 degree days has therefore been applied to the 1961-90 Climatic Research Unit monthly gridded climatology at 30 minute latitude and longitude resolution (see Fig 12 for a map of Europe and 13 for the EPPO Region).

Fig. 12 Map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 250 with the locations of *Drosophila suzukii* in Europe

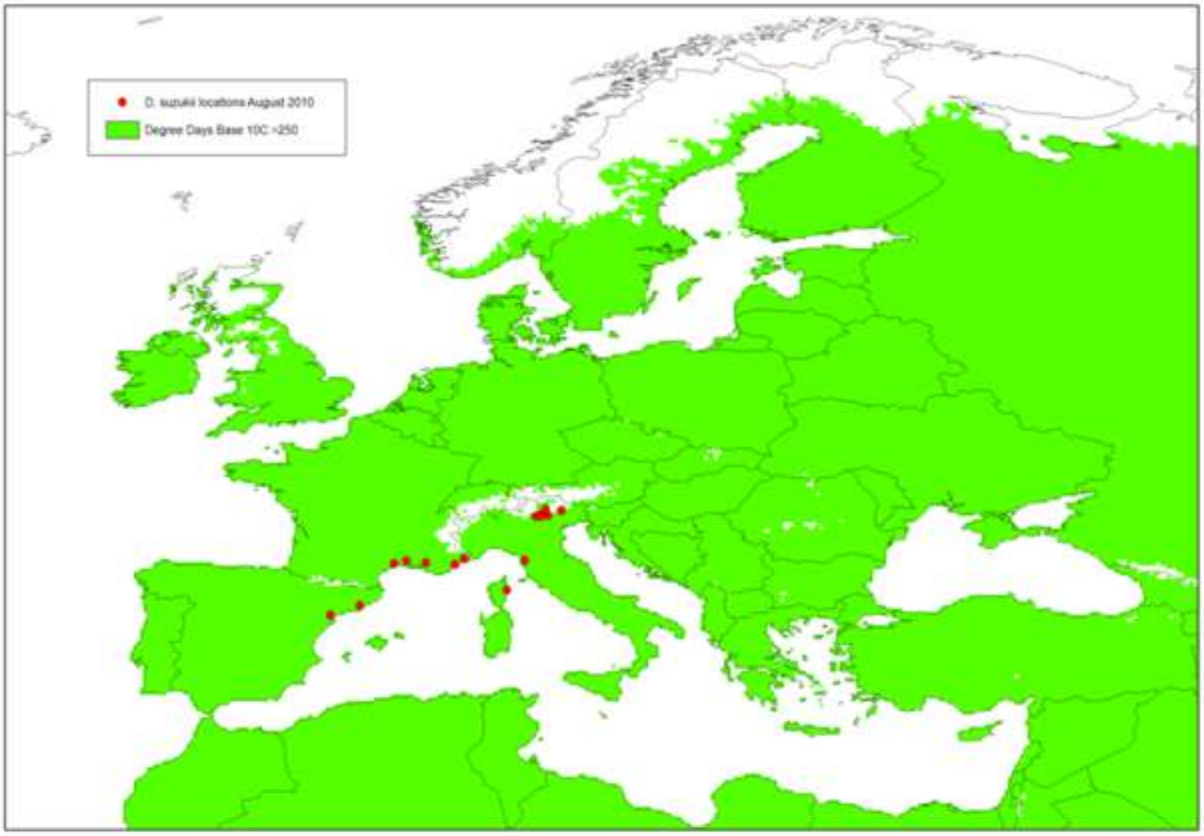
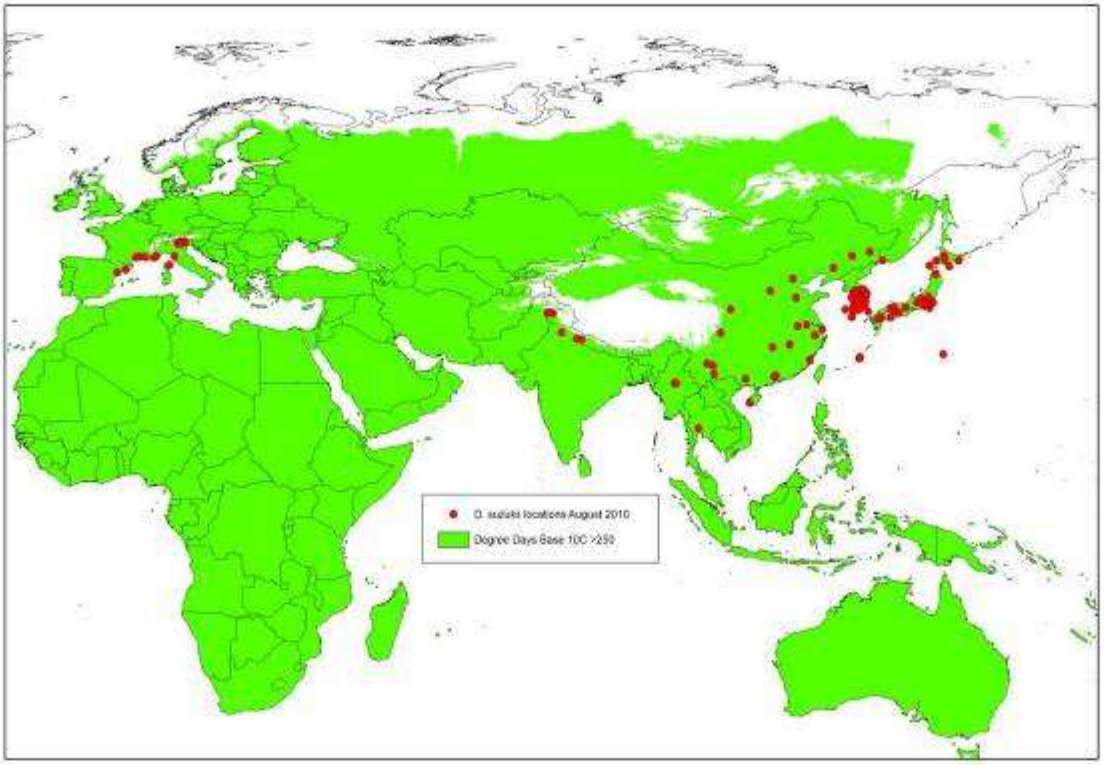


Fig. 13 Map showing the area where annual degree day accumulation above a base temperature of 10°C exceeds 250 with the locations of *Drosophila suzukii* in Europe and Asia



2.5 CLIMEX

Damus (unpublished) has parameterised CLIMEX (compare locations module) (Fig. 14) based on climatic responses in the literature (see above) and its known distribution in Asia producing maps of the ecoclimatic index (EI) for North America and Europe. In Figs 15 &16 the Panel has mapped the EI for the world and Europe using the same parameters and threshold provided by Damus (unpublished)). He states that this is a preliminary model and is keen to develop this further in collaboration.

Fig. 14 CLIMEX parameters used by Damus (Unpublished)

Climex model parameters:

Moisture Index

SM0	SM1	SM2	SM3
0.4	0.7	1.75	2

Temperature Index

DV0	DV1	DV2	DV3
9.1	20	28	32

Light Index (not used), Diapause Index (not used)

Cold Stress

TTCS	THCS	DTCS	DHCS	TTCSA	THCSA
-11	-0.0005	0	0	0	0

Heat Stress

TTHS	THHS	DTHS	DHHS
36	0.0007	0	0

Dry Stress

SMDS	HDS
0.3	-0.001

Wet Stress (not used), Cold-Dry Stress (not used),
Cold-Wet Stress (not used)

Hot-Dry Stress

TTHD	MTHD	PHD
30	0.3	0.001

Hot-Wet Stress (not used)

Day-degree accumulation above DV0

DV0	DV3	MTS
9.1	32	7

Day-degree accumulation above DVCS

DVCS	*DV4	MTS
12	100	7

Day-degree accumulation above DVHS

DVHS	*DV4	MTS
36	100	7

Degree-days per Generation

PDD
268

Fig. 15 Global map of the CLIMEX ecoclimatic index for *Drosophila suzukii* using parameters from Damus (Unpublished)

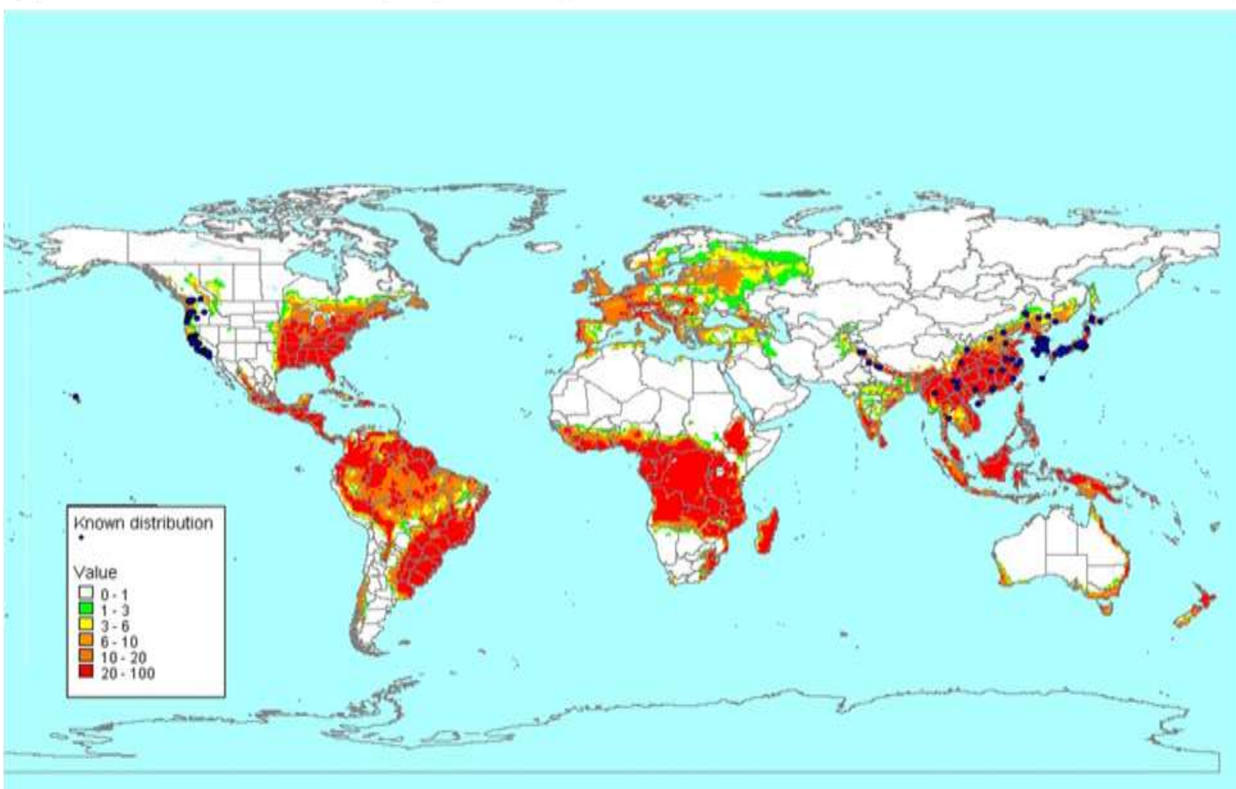


Fig. 16 Map of the CLIMEX ecoclimatic index in Asia and Europe for *Drosophila suzukii* using parameters from Damus (Unpublished)

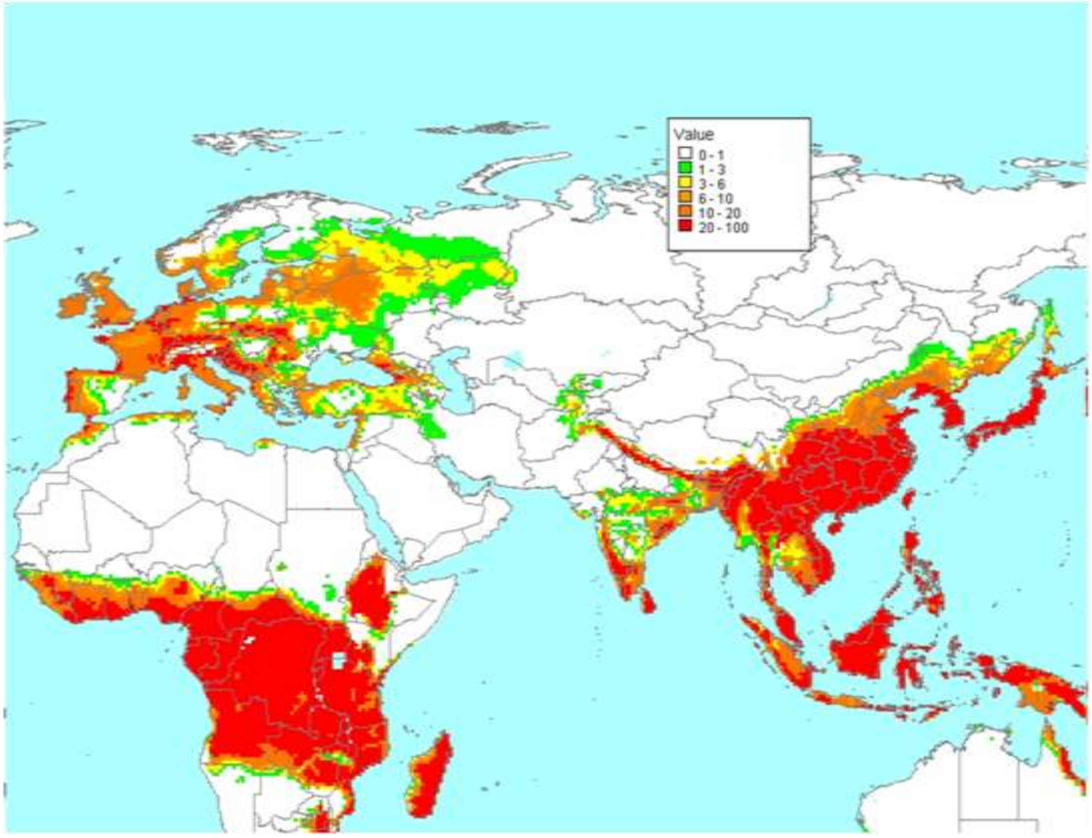
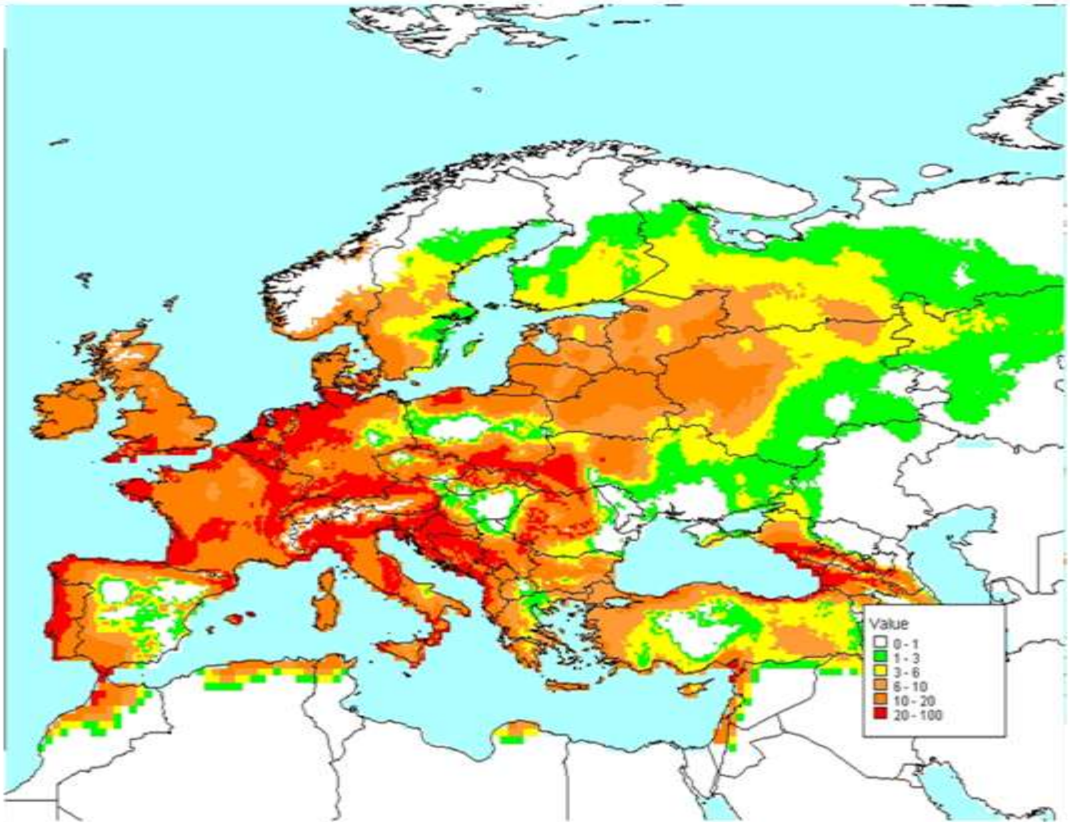


Fig. 17 Map of the CLIMEX ecoclimatic index in Europe for *Drosophila suzukii* using parameters from Damus (Unpublished)



The Panel considered that the model provides a reasonably good fit with the distribution in Asia. However, the observation from Kimura (pers. comm.) that the overwintering survival of *D. suzukii* in Hokkaido is low suggests that the cold stress parameters should be changed to reduce the high EI calculated for the island. The low minimum temperature threshold of 9.1ºC could also be raised to 10ºC and the degree days for each generation reduced to 250 to reflect better the known biology. Concerns were also expressed that the thresholds for unsuitable (< 1), marginal (1-3), suitable (4-6), good (7-10) etc were possibly too optimistic and could be reset to accord with the low overwintering survival of *D. suzukii* in Hokkaido. The very low or zero ecoclimatic index in central and eastern Spain is due to insufficient moisture during the hottest part of the year, though it is surprising that the same does not occur elsewhere in the southern Mediterranean countries of the EU, e.g. southern Italy, Greece and Cyprus.

3. Conclusions

Rating: **largely similar**
Level of uncertainty: **Low**

Visual examination of the Köppen-Geiger climate zones, hardiness zones and degree day maps shows that the climate in its current area of distribution is largely similar to that in the PRA area where hosts are present. Only northern areas of Europe and Russia where hosts are present are unsuitable. In many areas, there are sufficient accumulated degree days for numerous generations to be completed in the summer. Although 250 degree days is required for development from egg to adult, a simple division of the annual degree days to obtain a map of the number of generations possible in an area is probably not appropriate because (a) an additional period is usually required by insects before adults are ready to oviposit, (b) considerable individual variation can be expected with overlapping generations occurring and (c) the grid cells summarise and interpolate climate measured at weather stations and many locations within each grid cell will have different temperature accumulations. Although the higher the degree day accumulation above 10ºC, the greater the number of generations expected, the species cannot tolerate high temperatures if humidities are low and, in the southern Mediterranean areas, the species may survive only in irrigated crops. Information from Trentino in northern Italy, suggests that the species can be abundant even in areas where the degree day accumulations indicate that only one or two generations per year can be completed.

References

Baker, R.H.A. 2002. Predicting the limits to the potential distribution of alien crop pests. In: *Invasive Arthropods in Agriculture. Problems and Solutions*, Hallman, G.J. & Schwalbe, C.P. (Eds). pp. 207-241. Science Publishers Inc. Enfield USA.

Biosecurity Australia, 2010. Draft pest risk analysis report for *Drosphila suzukii*. http://www.daff.gov.au/__data/assets/pdf_file/0009/1825497/pra-report-drosophila-final.pdf

Kottek, M., Grieser, J., Beck C., Rudolf, B. & Rubel, F. 2006. World map of Köppen- Geiger climate classification updated. *Meteorologische Zeitschrift*, **15**: 259-263.

Leather, S.R., Walters, K.F.A & Bale, 1993. The Ecology of Insect Overwintering. Cambridge University Press.

Magarey, R.D., Borchert, D.M. & Schlegel, J.W. 2008. Global plant hardiness zones for phytosanitary risk analysis. *Scientia Agricola*, **65**: 54-59.

New, M., Lister, D. Hulme, M. Makin, I. 2002. A high-resolution data set of surface climate over global land areas. *Climate Research*, **21**: 1-25.

Figures

1	Global distribution of *Drosophila suzukii*
2	Global distribution of the 13 Köppen-Geiger climate zones inhabited by *Drosophila suzukii* (based on Kottek et al., 2006)
3	Global map of hardiness zones (based on Magarey et al., 2008)
4	Hardiness zones in eastern Asia
5	Hardiness zones in Europe
6	Global map of annual degree day accumulation above a base temperature of 10ºC (based on Baker, 2002) using the Climatic Research Unit Global Climatology for 1961-90 interpolated to 0.5º latitude and longitude (New et al., 2002)
7	Map of annual degree day accumulation above a base temperature of 10ºC and the locations of *Drosophila suzukii* in Eastern Asia
8	Map of annual degree day accumulation above a base temperature of 10ºC with the locations of *Drosophila suzukii* in Western North America
9	Map of annual degree day accumulation above a base temperature of 10ºC in Europe
10	Global map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 500
11	Map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 500 in Europe and Asia
12	Map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 250 with the locations of *Drosophila suzukii* in Europe
13	Map showing the area where annual degree day accumulation above a base temperature of 10ºC exceeds 250 with the locations of *Drosophila suzukii* in Europe and Asia
14	CLIMEX parameters for *Drosophila suzukii* used by Damus (Unpublished)
15	Global map of the CLIMEX ecoclimatic index for *Drosophila suzukii* using parameters from Damus (Unpublished)
16	Map of the CLIMEX ecoclimatic index in Asia and Europe for *Drosophila suzukii* using parameters from Damus (Unpublished)
17	Map of the CLIMEX ecoclimatic index in Europe for *Drosophila suzukii* using parameters from Damus (Unpublished)