

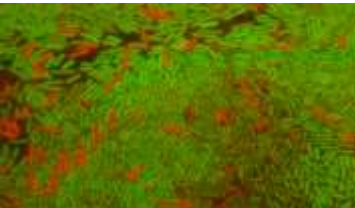


ISFC 2018

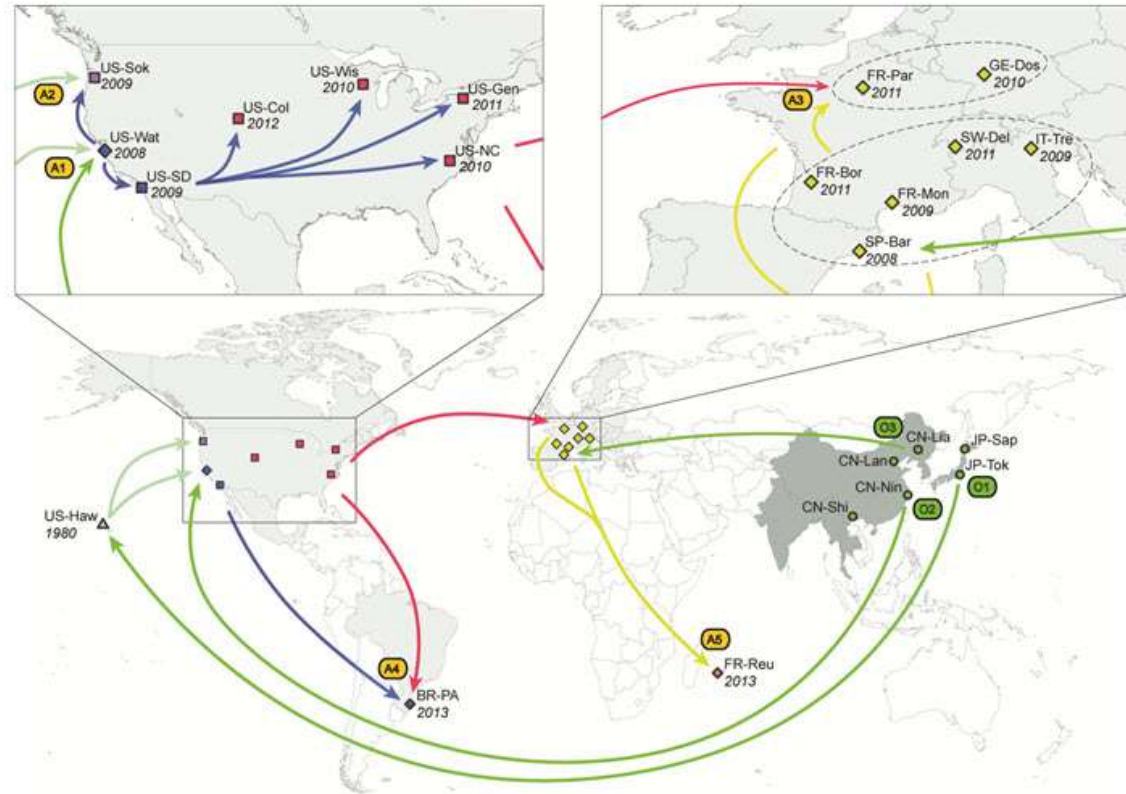
# Managing pathways of pest and disease introduction

John MUMFORD and Gritta Schrader  
with John Holt and Adrian Leach

Imperial College  
London



# Where did SWD come from?



From: Deciphering the Routes of invasion of *Drosophila suzukii* by Means of ABC Random Forest Mol Biol Evol. 2017;34(4):980-996. doi:10.1093/molbev/msx050 Mol Biol Evol | © The Author 2017. Published by Oxford University Press



# How does infested fruit move?

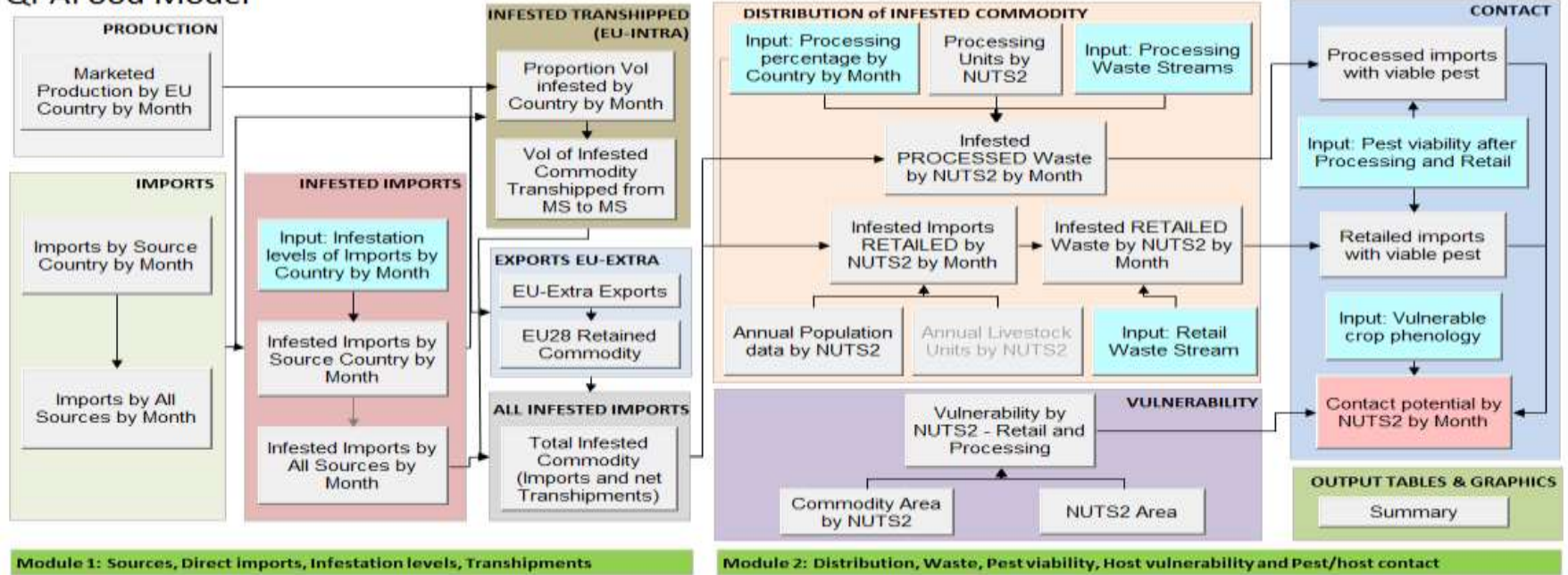
- DROPSA has extended a Quantitative Pathway Analysis model
  - Global fruit trade data into and around EU
  - Within EU Transshipments
  - Exports from EU
  - Total infested commodity by MS by month
  - Retail distribution by NUTS2 statistical region by month
  - Processing distribution by NUTS2 by month

# How does SWD reach EU crops?

- DROPSA has extended a Quantitative Pathway Analysis model
  - Infestation level in imports
  - Pest viability in fruit and waste
  - Pest mobility
  - Host distribution
  - Host phenology by month
  - **Contact risk by NUTS2 by month**

# Model

## QPAFood Model



# Net volumes (100Kg) of each infested commodity arriving in (+) or leaving (-) Member States per annum

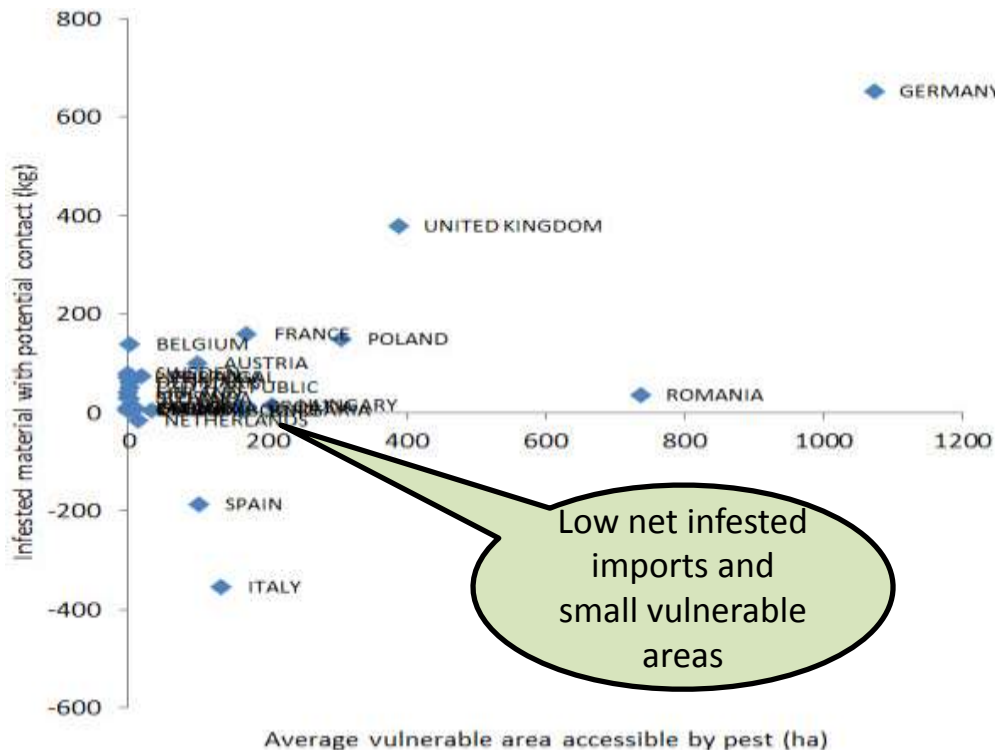
| Mean direct imports plus net transhipments 2011-2015 | Apple | Blueberry | Cherry | Currant | Fig | Grape | Kiwi | Peach | Pear | Plum | Raspberry | Strawberry |
|--|-------|-----------|--------|---------|-----|-------|------|-------|------|------|-----------|------------|
| AUSTRIA  | 126   | 0         | 2      | 0       | 1   | 47    | 16   | 57    | 28   | 10   | 8         | 38         |
| BELGIUM (and LUXBG -> 1998)                          | 153   | 0         | 9      | 0       | 3   | 64    | 25   | 96    | 42   | 20   | 3         | 30         |
| BULGARIA   | 13    | 0         | 0      | 0       | 0   | 3     | 0    | 1     | 1    | 0    | 0         | 0          |
| CYPRUS   | 10    | 0         | 0      | 0       | 0   | 0     | 0    | 0     | 2    | 0    | 0         | 0          |
| CZECH REPUBLIC (CS->1992)                            | 12    | 0         | 0      | -1      | 1   | 59    | 11   | 54    | 11   | 0    | 0         | 17         |
| GERMANY (incl DD from 1991)                          | 798   | 0         | 20     | 3       | 4   | 355   | 121  | 477   | 178  | 58   | 13        | 162        |
| DENMARK  | 93    | 0         | 1      | 0       | 1   | 26    | 6    | 29    | 24   | 10   | 1         | 12         |
| ESTONIA  | 7     | 0         | 0      | 0       | 0   | 5     | 1    | 4     | 3    | 1    | 0         | 1          |
| SPAIN  | 272   | 0         | -22    | 0       | -6  | -84   | 84   | -542  | -35  | -64  | -5        | -220       |
| FINLAND  | 67    | 0         | 1      | 0       | 0   | 21    | 5    | 15    | 1    | 1    | 0         | 2          |
| FRANCE   | -236  | 0         | 9      | 0       | 12  | 248   | 38   | 207   | 90   | 13   | 0         | 0          |
| UNITED KINGDOM                                       | 559   | 0         | 33     | 1       | 3   | 202   | 32   | 141   | 130  | 67   | 17        | 72         |
| GREECE   | 19    | 0         | 0      | 0       | 0   | 1     | 1    | 2     | 8    | 0    | 0         | 1          |
| CROATIA  | -2    | 0         | 0      | 0       | 0   | 11    | 5    | 17    | 7    | 1    | 0         | 2          |
| HUNGARY  | 20    | 0         | 0      | 0       | 0   | 8     | 7    | 10    | 2    | 0    | 0         | 3          |
| IRELAND  | 64    | 0         | 1      | 0       | 0   | 13    | 4    | 7     | 6    | 3    | 2         | 2          |
| ITALY  | -520  | 0         | 3      | 2       | -3  | -386  | -190 | -98   | -33  | -19  | 6         | 51         |
| LITHUANIA  | 85    | 0         | 2      | 0       | 0   | 24    | 14   | 56    | 43   | 4    | 1         | 6          |
| LUXEMBOURG   | 5     | 0         | 0      | 0       | 0   | 3     | 1    | 2     | 1    | 1    | 0         | 2          |
| LATVIA   | 11    | 0         | 0      | 0       | 0   | 5     | 3    | 8     | 4    | 1    | 0         | 1          |
| MALTA  | 8     | 0         | 0      | 0       | 0   | 2     | 1    | 3     | 1    | 1    | 0         | 0          |
| NETHERLANDS  | -22   | 0         | 1      | 0       | 1   | 51    | 26   | 46    | -168 | 11   | -1        | -9         |
| POLAND   | 39    | 0         | 1      | 0       | 1   | 176   | 40   | 176   | 32   | 16   | 2         | 20         |
| PORTUGAL   | 77    | 0         | 4      | 0       | 2   | 40    | 7    | 76    | 4    | 10   | 0         | 26         |
| ROMANIA  | 50    | 0         | 0      | 0       | 0   | 23    | 5    | 26    | 15   | 1    | 0         | 1          |
| SWEDEN   | 120   | 0         | 2      | 0       | 1   | 30    | 14   | 45    | 34   | 8    | 1         | 8          |
| SLOVENIA   | 1     | 0         | 0      | 0       | 0   | 7     | 3    | 16    | 5    | 2    | 0         | 3          |
| SLOVAKIA   | 35    | 0         | 0      | 0       | 0   | 23    | 7    | 21    | 5    | 2    | 0         | 3          |

Germany is big importer of infested peaches

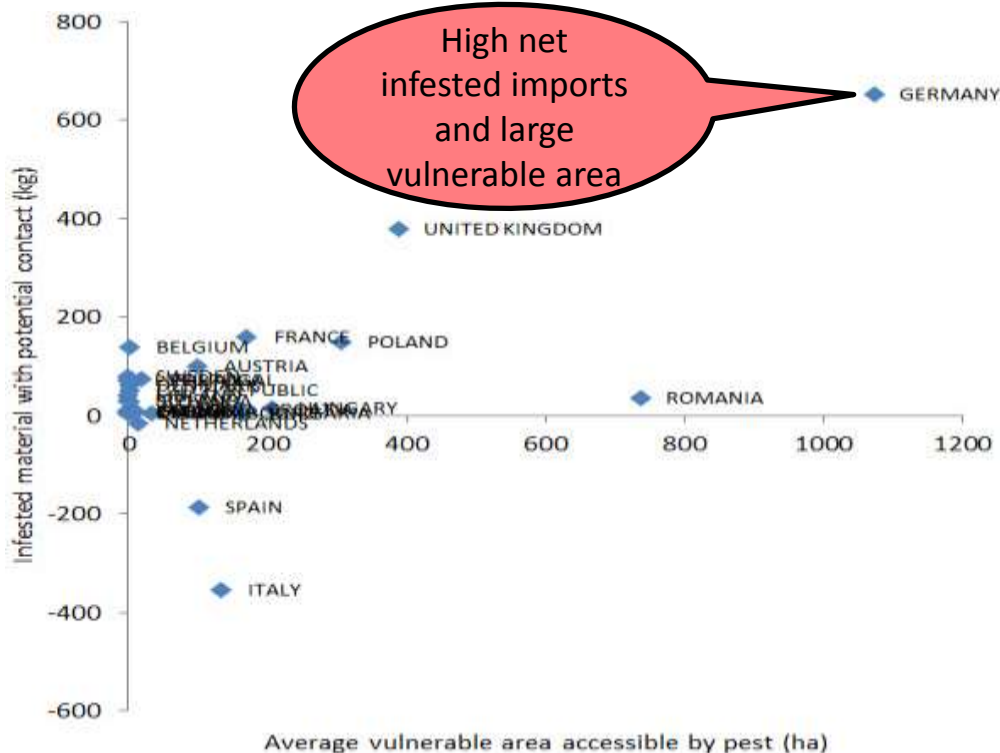
Spain is big exporter of infested peaches



# Example output: Annual risks to plum from trade in *D. suzukii* host commodities for the EU28 countries

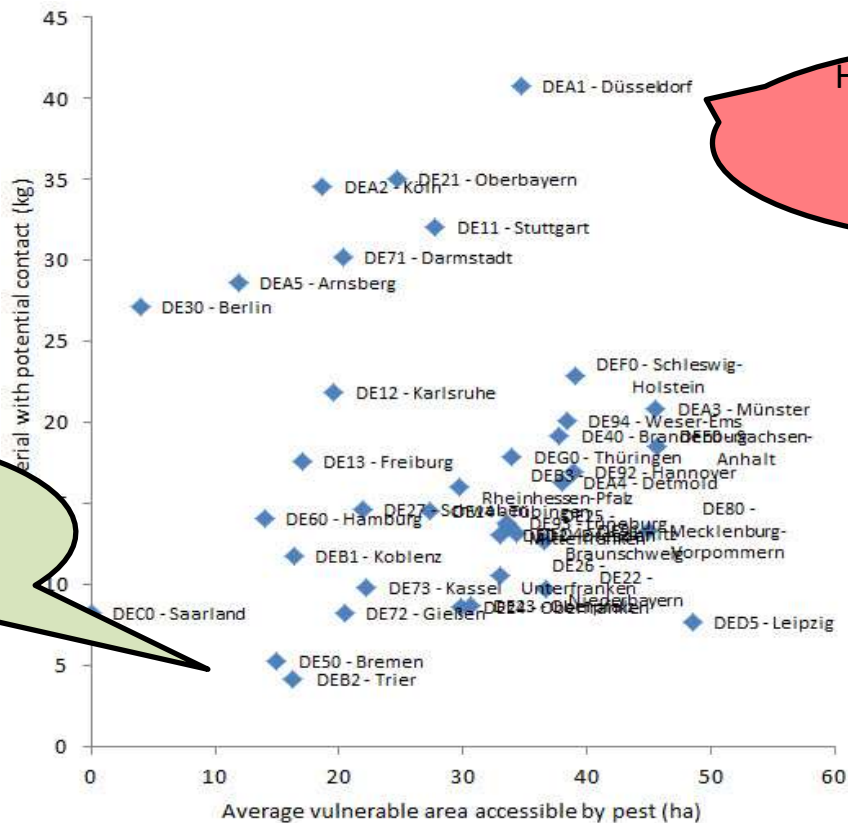


# Example output: Annual risks to plum from trade in *D. suzukii* host commodities for the EU28 countries





# Example output: Annual risks to plum in *D. suzukii* commodities in **Germany**

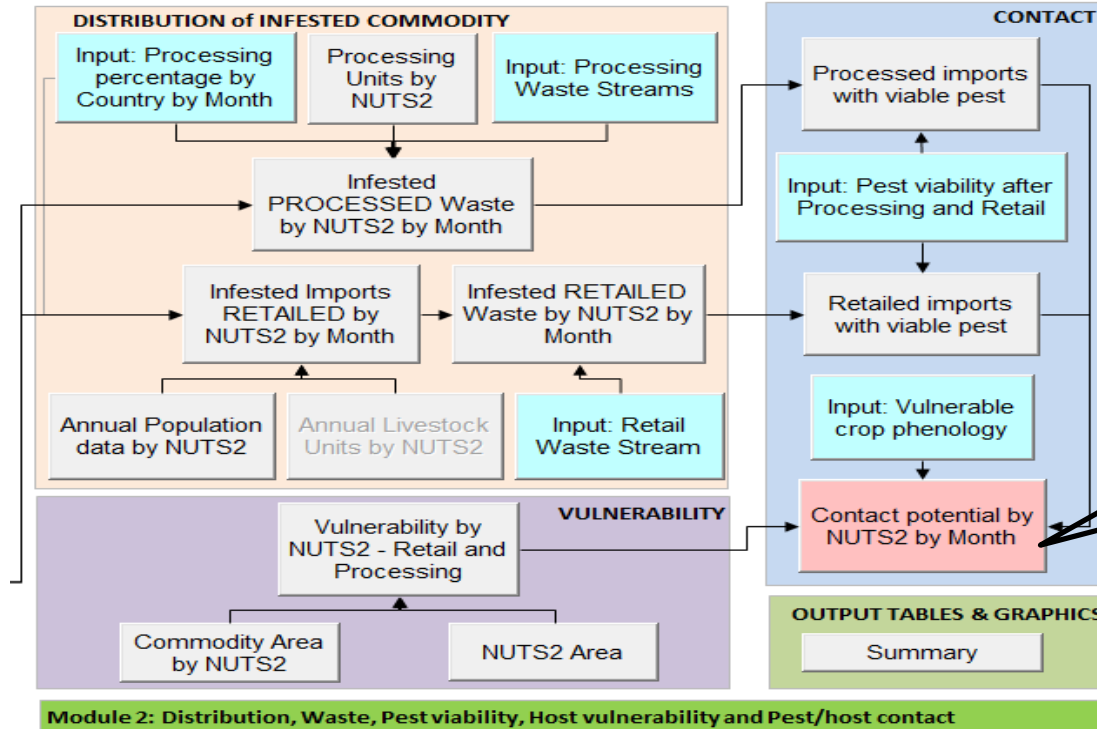


Low exposure to infested materials (low consumption) and low vulnerable area

High exposure to infested materials (high consumption) and large vulnerable area





# Calculation of overall contact risk by NUTS2 region



So far 6 pest/  
commodities have  
been modelled

# Comparison of risks of different commodity/pests by QPA model

| Rank | Commodity-Pest                          | Risk - All NUTS2  |
|------|---|---|
| 1    | Wheat - <i>Listronotus bonariensis</i>  | 146   |
| 2    | Plum - <i>Drosophila suzukii</i>        | 108      |
| 3    | Sweet orange - <i>Xanthomonas citri</i> | 5.2   |
| 4    | Apple - <i>Cydia prunivora</i>          | 1.7E-02   |
| 5    | Plum - <i>Conotrachelus nenuphar</i>    | 3.4E-03   |
| 6    | Apple - <i>Argyresthia assimilis</i>    | 8.0E-05  |

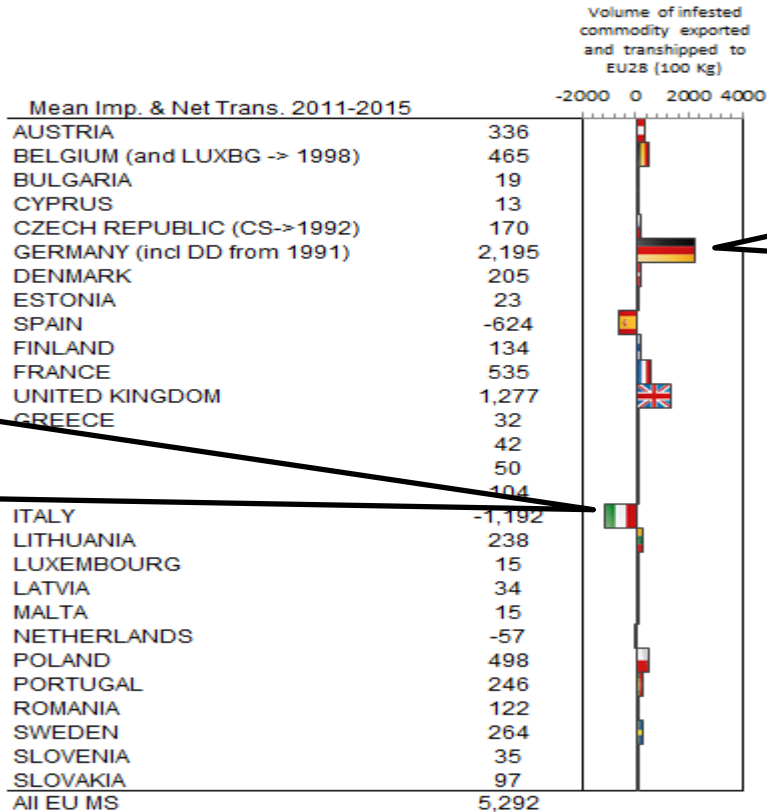
The values are average of all NUTS2 regions of annual pest-host contact as measured by hundreds of kilograms of infested commodity import or its waste which could lead to release of pests which could then reach a number of square kilometres of vulnerable host (100kg km<sup>2</sup> yr<sup>-1</sup>)



# How can we manage fruit in the trade?

- Inspection methods of monitoring fruit imports
- Identify countries and products with a high risk profile
- Identify risk prevention priorities for government and fruit industry

Net annual volume (100kg) of *D. suzukii* infested commodity arriving in member states summed across all commodity groups, where *D. suzukii* is present in a member state, net figure may be negative if MS exports more potentially infested commodity than it imports

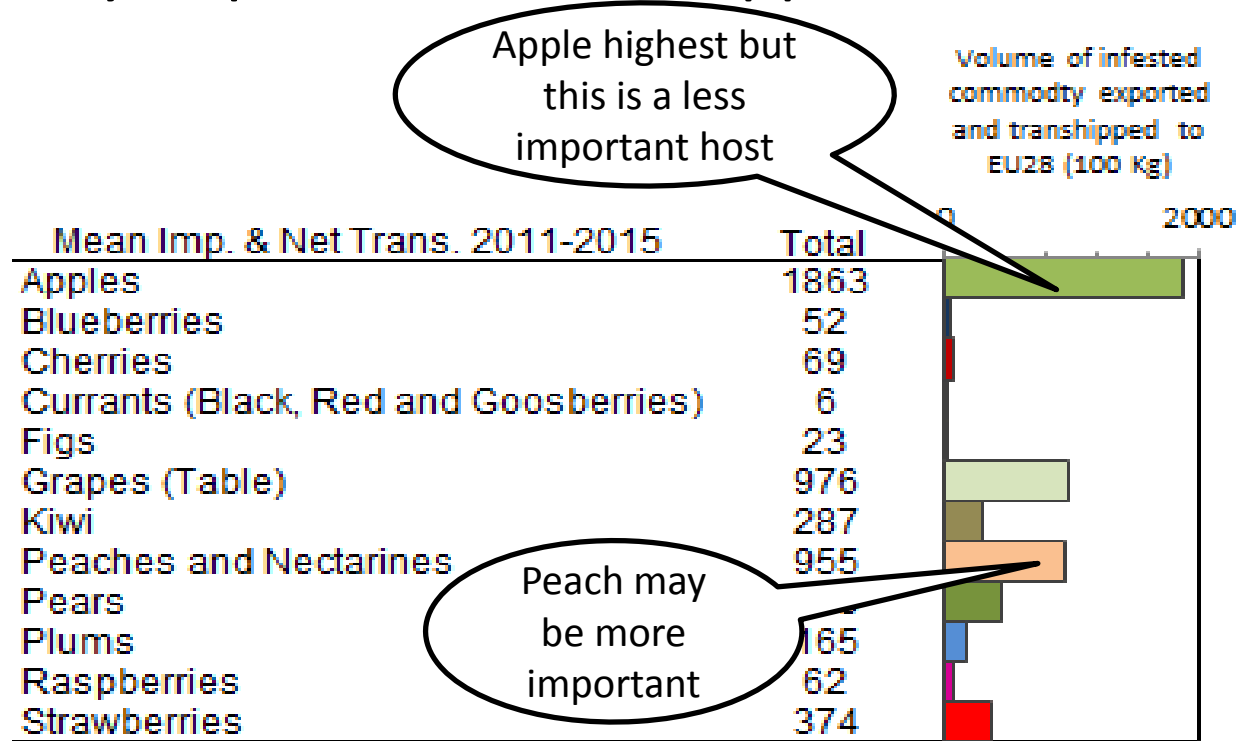


MS in which export of infested commodity exceeds import of infested commodity

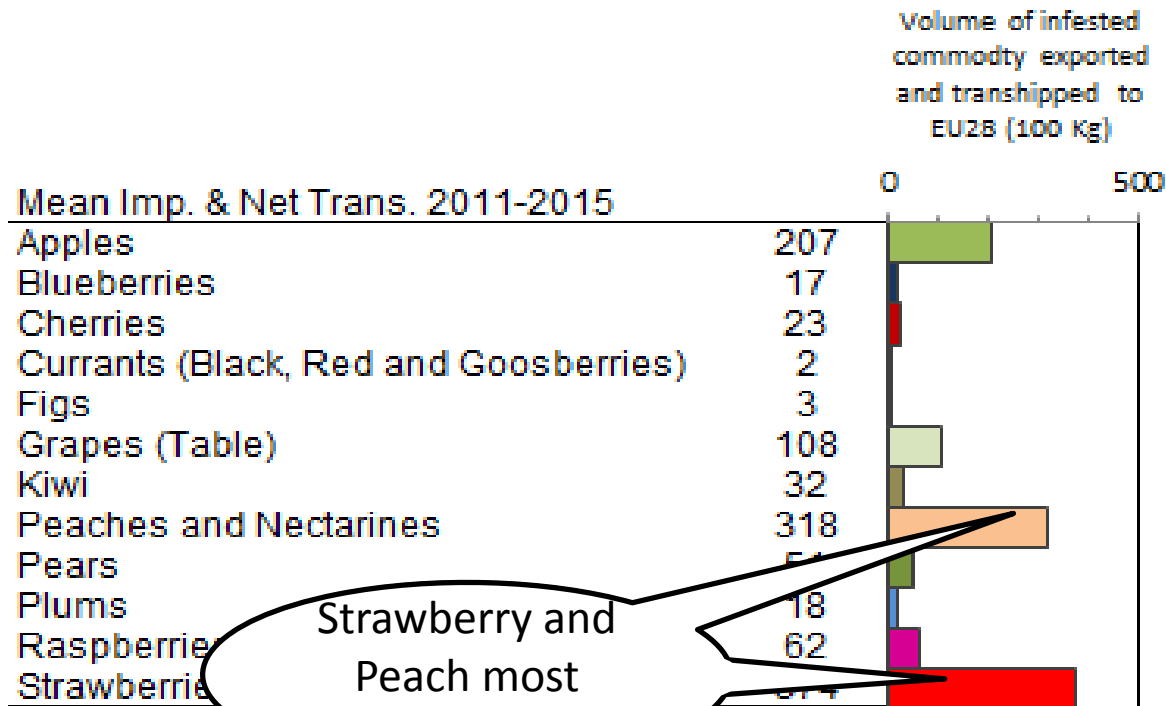
MS in which risk is increased by imports



# The relative quantities of potentially *D. suzukii*-infested commodity imported or transhipped to Member States



The relative number of *D. suzukii* imported and transhipped to Member States, adjusted to reflect the susceptibility of the commodity to *D. suzukii* and the consequent estimated effect on pest numbers associated with a given volume of an infested commodity.



# Contact risk between *D. suzukii* infested fruit imports and plum production within the EU: top 20 NUTS 2 region/months with the highest contact risk

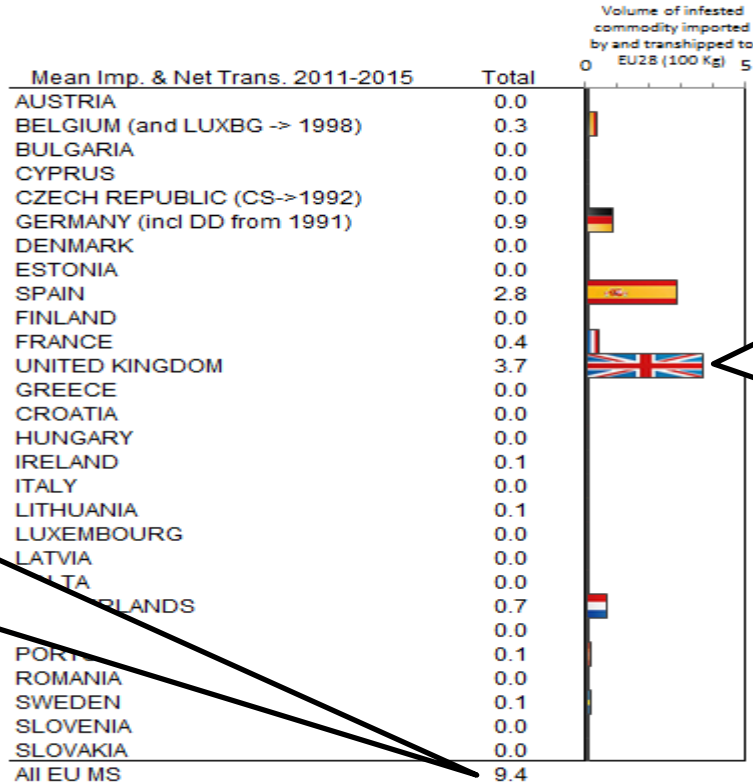
| Rank | NUTS2 Region                  | Month | Risk     | % Risk |
|------|-------------------------------|-------|----------|--------|
| 1    | UKJ4 - Kent                   | Sep   | 0.010151 | 2.9%   |
| 2    | UKJ4 - Kent                   | Aug   | 0.007038 | 2.8%   |
| 3    | DEA1 - Düsseldorf             | Sep   | 0.006843 | 1.9%   |
| 4    | DEA1 - Düsseldorf             | Aug   | 0.004722 | 1.3%   |
| 5    | DEA3 - Münster                | Sep   | 0.004591 | 1.3%   |
| 6    | DEA3 - Münster                | Aug   | 0.004444 | 1.3%   |
| 7    | DEF0 - Schleswig-Holstein     | Aug   | 0.004412 | 1.3%   |
| 8    | DE11 - Stuttgart              | Sep   | 0.004321 | 1.2%   |
| 9    | DEF0 - Schleswig-Holstein     | Aug   | 0.004297 | 1.2%   |
| 10   | DE21 - Oberbayern             | Sep   | 0.00429  | 1.2%   |
| 11   | DE11 - Stuttgart              | Aug   | 0.004209 | 1.2%   |
| 12   | DEE0 - Sachsen-Anhalt         | Sep   | 0.004178 | 1.2%   |
| 13   | DE21 - Oberbayern             | Sep   | 0.004093 | 1.2%   |
| 14   | DEE0 - Sachsen-Anhalt         | Aug   | 0.003842 | 1.1%   |
| 15   | DE94 - Weser-Ems              | Aug   | 0.003781 | 1.1%   |
| 16   | HR04 - Kontinentalna Hrvatska | Sep   | 0.003735 | 1.1%   |
| 17   | DE94 - Weser-Ems              | Aug   | 0.003592 | 1.0%   |
| 18   | DE40 - Brandenburg            | Sep   | 0.003492 | 1.0%   |
| 19   | DE40 - Brandenburg            | Aug   | 0.003286 | 0.9%   |
| 20   | DE92 - Hannover               |       |          |        |

NUTS2 Region UKJ4 Kent, alone represents nearly 6% of the total risk within EU Member States

A large proportion of the total risk was distributed across many NUTS2 region in Germany



# The annual volume (100kg) of *A. assimilis* infested apple fruit imported and transhipped to member states



The entire potential infested import volume to Member States is less than 1 tonne

UK and Spain are the largest recipients of potentially infested imports from the source country, China

# The contact risk between *A. assimilis* infested apple imports and apple production within the EU. The top 20 NUTS 2 region/months of the year having the highest contact risk

| Rank | NUTS2 Region                | Month | Risk     | % Risk |   |
|------|-----------------------------|-------|----------|--------|---|
| 1    | ES61 - Andalucía            | Jul   | 9.72E-09 | 3.4%   | * |
| 2    | NL33 - Zuid-Holland         | Oct   | 8.72E-09 | 2.4%   |   |
| 3    | NL41 - Noord-Brabant        | Aug   | 6.65E-09 | 2.4%   |   |
| 4    | ES61 - Andalucía            | Aug   | 6.46E-09 | 2.3%   | * |
| 5    | LT00 - Lietuva              | Oct   | 5.86E-09 | 2.1%   |   |
| 6    | NL32 - Noord-Holland        | Oct   | 5.69E-09 | 2.0%   |   |
| 7    | ES51 - Cataluña             | Jul   | 5.2E-09  | 1.8%   |   |
| 8    | ES30 - Comunidad de Madrid  | Jul   | 4.38E-09 | 1.5%   |   |
| 9    | UKH1 - East Anglia          | Aug   | 4.31E-09 | 1.5%   |   |
| 10   | ES52 - Comunidad Valenciana | Jul   | 3.86E-09 | 1.4%   |   |
| 11   | ES51 - Cataluña             | Aug   | 3.45E-09 | 1.2%   |   |
| 12   | NL42 - Limburg (NL)         | Oct   | 3.09E-09 | 1.1%   |   |
| 13   | ES41 - Castilla y León      | Jul   | 2.95E-09 | 1.0%   |   |
| 14   | ES42 - Castilla-La Mancha   | Jul   | 2.95E-09 | 1.0%   |   |
| 15   | ES30 - Comunidad de Madrid  | Aug   | 2.91E-09 | 1.0%   |   |
| 16   | LT00 - Lietuva              | Aug   | 2.88E-09 | 1.0%   |   |
| 17   | NL22 - Gelderland           | Oct   | 2.81E-09 | 1.0%   |   |
| 18   | NL33 - Zuid-Holland         | Sep   | 2.7E-09  | 1.0%   |   |
| 19   | NL41 - Noord-Brabant        | Sep   | 2.62E-09 | 0.9%   |   |
| 20   | ES52 - Comunidad Valenciana | Aug   | 2.56E-09 | 0.9%   |   |

NUTS2 Region ES61  
Andalucia, alone  
represents nearly 6%\*  
of the total risk within  
EU Member States

A large proportion  
of the total risk was  
distributed across  
NUTS2 regions in Spain,  
The Netherlands and  
Latvia