PRAs: Tools, Resources and Key Challenges

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23rd September 2003

Outline of the Talk

- PRA: the need for tools and resources in addition to standards
- Examples of tools and resources in the different stages of pest risk assessment:
  - Pest categorisation
    - Commodity pest risk assessment for potatoes from New Zealand
  - Entry
    - *Thrips palmi* (Palm or melon thrips)
  - Establishment
    - *Diabrotica virgifera virgifera* (Western corn rootworm)
  - Economic & Environmental Impacts
    - *Bemisia tabaci*
    - *Phytophthora ramorum*
- Key Challenges

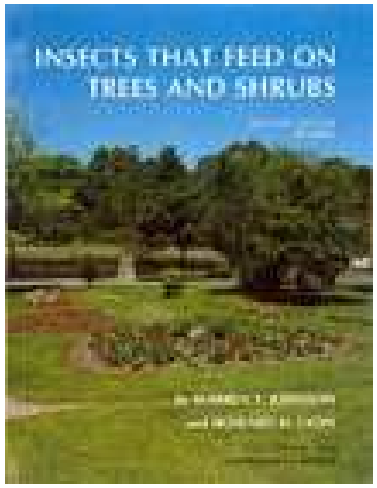
PRA Tools and Resources required as well as Standards

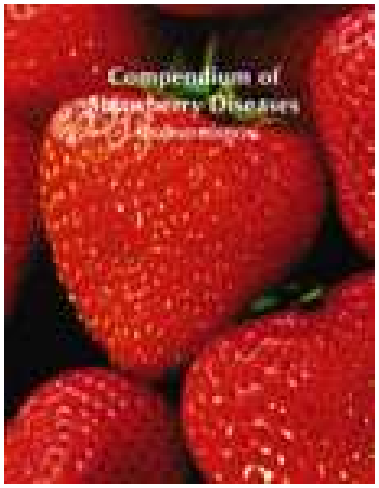
- ISPM 11 tells you what to do but not how to do it or where to obtain the data needed, e.g.
  - “Documented pathways for the pest to enter new areas should be noted…” (2.2.1)
  - “Climatic modelling systems may be used…” (2.2.2.2)
  - “There are analytical techniques which can be used in consultation with experts in economics….” (2.3.2.3)

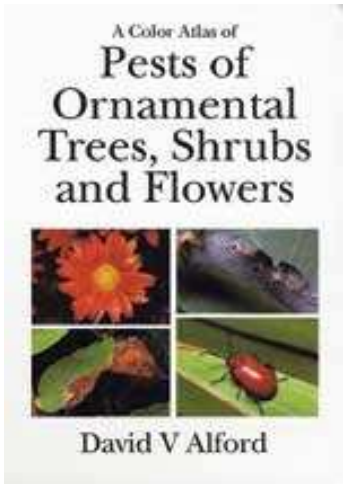
Examples of resources and tools used in PRA - Pest Categorization

- Resources
  - Taxonomic keys
  - National Species Lists
- Tools
  - electronic, e.g. CABI Compendia
- Example
  - Commodity risk analysis of ware potatoes from New Zealand

Some Sources of Information on Pests







Phytosanitary Alert System
NAPPO

Google™

Invertebrate potato pests (New Zealand)

Compile pest list		84
Pests common to NZ and UK	52	
Consider pathway and life stage	17	
		(69)
Pests for PRA		15

References, such as:

Scott, R.R. (1984) (Ed.) *New Zealand pest and beneficial insects.* Lincoln University 273pp

Spiller, D.M. & Wise, K.A.J. (edited and revised by Dale, P.S. & Maddison (1982)) *A Catalogue of New Zealand insects and their host plants.* New Zealand DSIR, Bulletin 231, 260pp.

Examples of resources and tools used in PRA - Entry

- Resources
  - Trade import data
  - Detection datasets
- Tools
  - Spreadsheets
- Example
  - UK and EU import detections

Factors determining the Probability of Entry

- Number and variety of pathways
- Association of pest with the pathway
- Survival in transit
- Probability of surviving phytosanitary procedures
- Probability of surviving cultural/industrial practices
- Transfer to a suitable host

UK interceptions of *Bemisia tabaci* on Third Country produce

	CANARY ISL	GAMBIA	GHANA	**ISRAEL**	JORDAN	NIGERIA	SIERRA LEO	SINGAPORE	unspecified	ZIMBABWE	totals
ARTEMISIA				**1**							1
ASTER				**1**							1
CALLISTEPHUS				**1**							1
CHRYSOPHYLLUM						1					1
DENDRANTHEMA	6			**1**							7
GYPSOPHILA				**5**							5
HIBISCUS			1								1
HYPERICUM				**5**					1		6
LIMONIUM									1		1
MANIHOT		4				2	4				10
MENTHA				**2**							2
OCIMUM	1			**2**							3
ORIGANUM				**4**							4
PHILODENDRON								1			1
ROSA				**3**							3
SALVIA				**2**							2
SOLIDAGO	**1**			**46**					**1**		**48**
SOLIDASTER				**1**						1	2
TRACHELIUM				**2**							2
unidentified		1		**1**	1		1				4
totals	8	5	1	**77**	1	3	5	1	3	1	105

Source: Unpublished CSL data

Sample TARIC code trade data

Imports of Fresh or Chilled Potatoes into UK					
Source: COMEXT CD					
Units: Tonnes					
1993					
	JANUARY	FEBRUARY	MARCH	.... DECEMBER	ANNUAL
	93-01	93-02	93-03	 93-12	TOTAL
001 FRANCE	298	946	711	808	**24,011**
002 BELG.-LUXBG.	60	420	432	300	**51,154**
003 NETHERLANDS	1370	5720	5034	3634	**42,969**
004 GERMANY	0	48	23	0	**1,339**
005 ITALY	1911	537	252	2759	**11,489**
007 IRELAND	49	50	49	133	**5,605**
008 DENMARK	0	0	0	0	**1**
009 GREECE	20	168	0	0	**767**
010 PORTUGAL	94	87	21	274	**1,670**
011 SPAIN	75	80	1020	292	**8,940**
021 CANARY ISLANDS	4	0	0	0	**4**
030 SWEDEN	0	3	0	0	**3**
038 AUSTRIA	21	42	147	0	**210**
204 MOROCCO	77	59	190	3	**472**
212 TUNISIA	0	14	0	0	**14**
220 EGYPT	10556	23600	21770	1964	**68,154**
600 CYPRUS	3840	1023	798	3288	**73,163**
624 ISRAEL	185	241	355	40	**940**

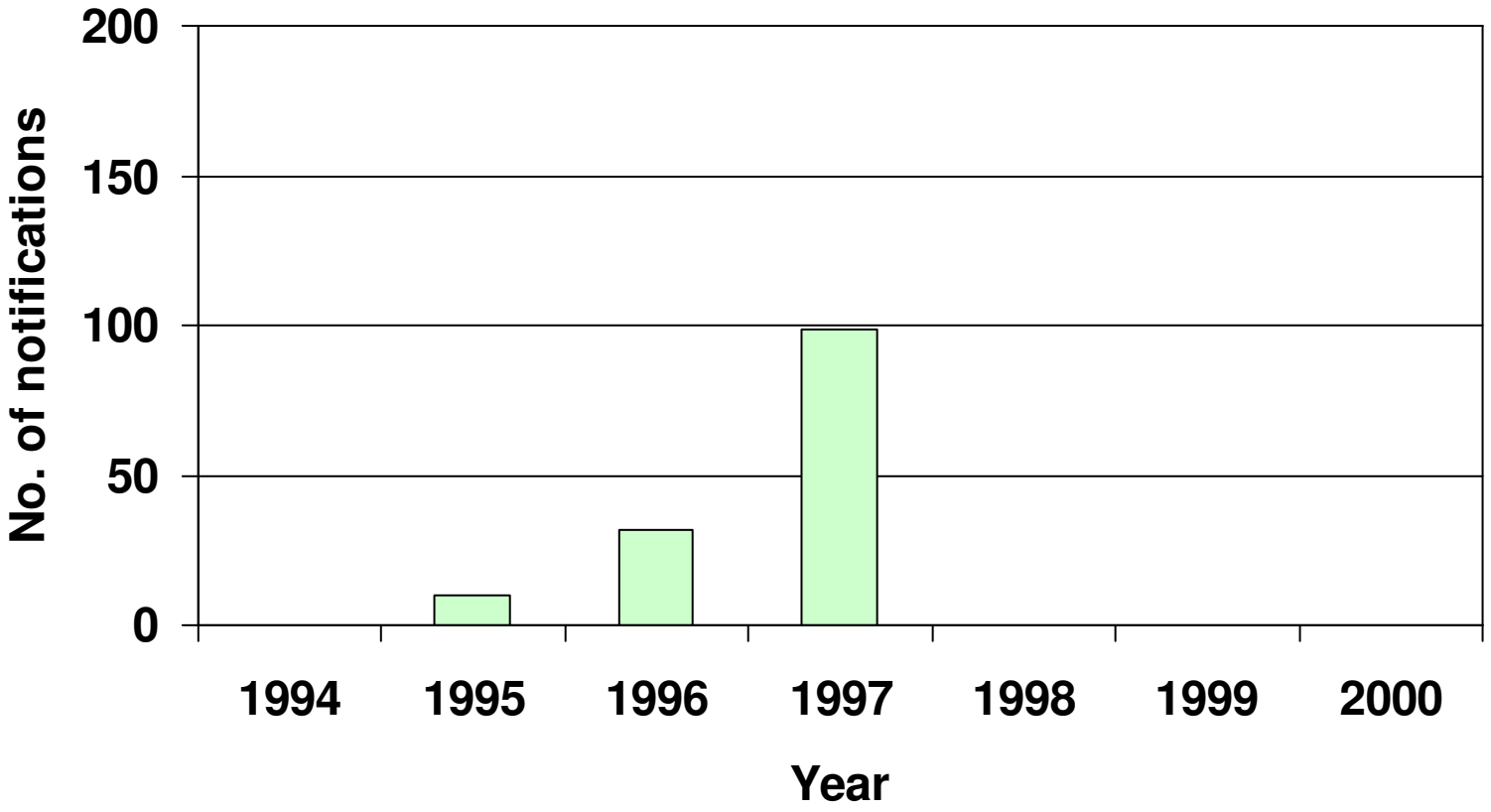
Source: COMEXT CD

Trade data:
Changes over time, e.g. increased trade in cut flowers

- UK consumption of cut flowers
  - 1991 50,475 tonnes
  - 1998 102,884 tonnes

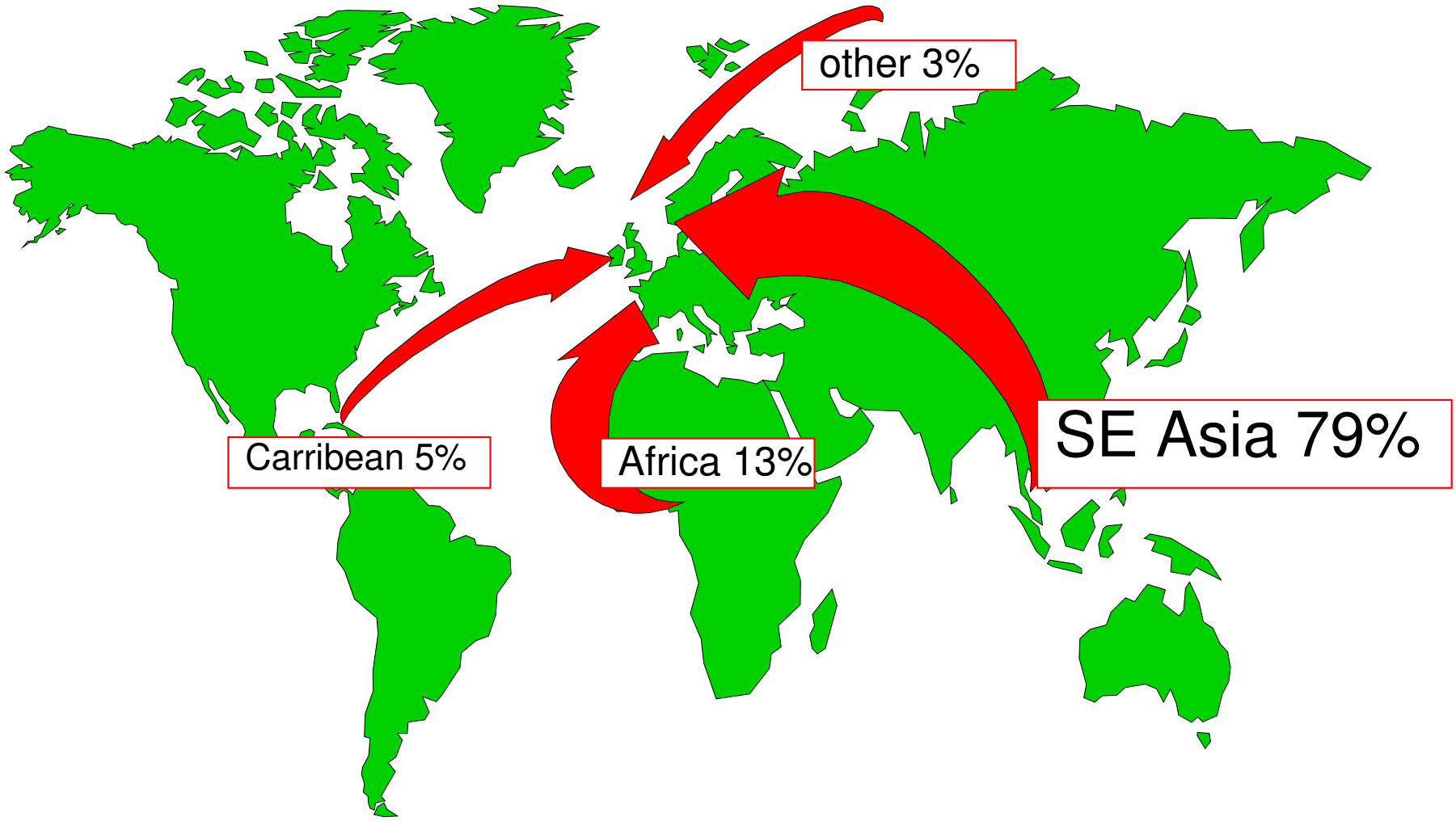
- Sources of cut flowers include: Argentina, Australia, Brazil, China, Colombia, Costa Rica, Denmark, Dominica, France, Germany, Guatemala, Hungary, India, Ireland, Israel, Italy, Japan, Kenya, Kuwait, Mexico, Netherlands, New Zealand, Norway, Portugal, Romania, Singapore, South Africa, Spain, Sri Lanka, Sweden, Taiwan, Thailand, Togo, USA

EU notifications of *Thrips palmi* on Thai orchids



Data source: EU FVO Office, Notifications of non compliance

Origins of *Thrips palmi* interceptions by EU Member States



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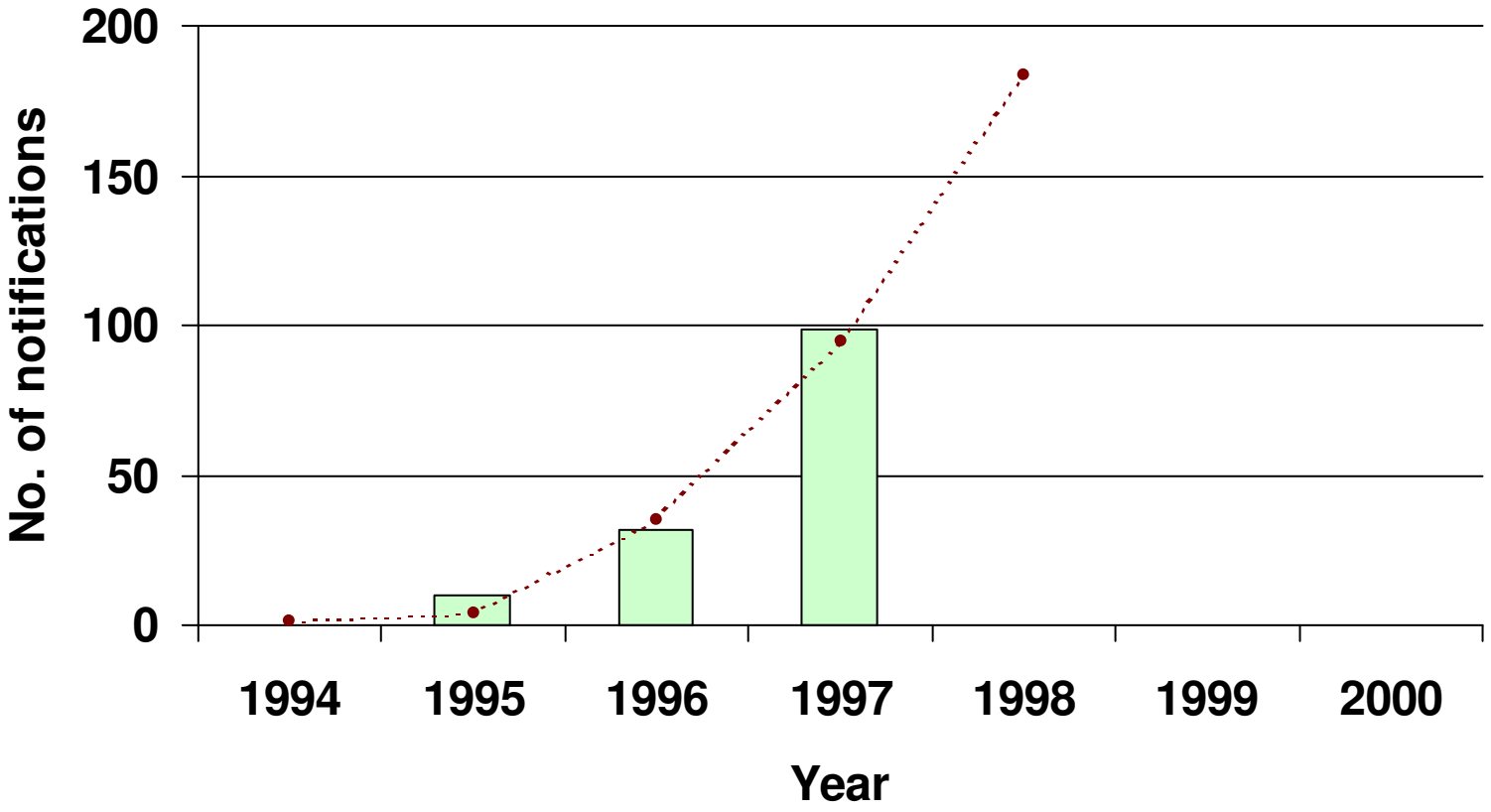

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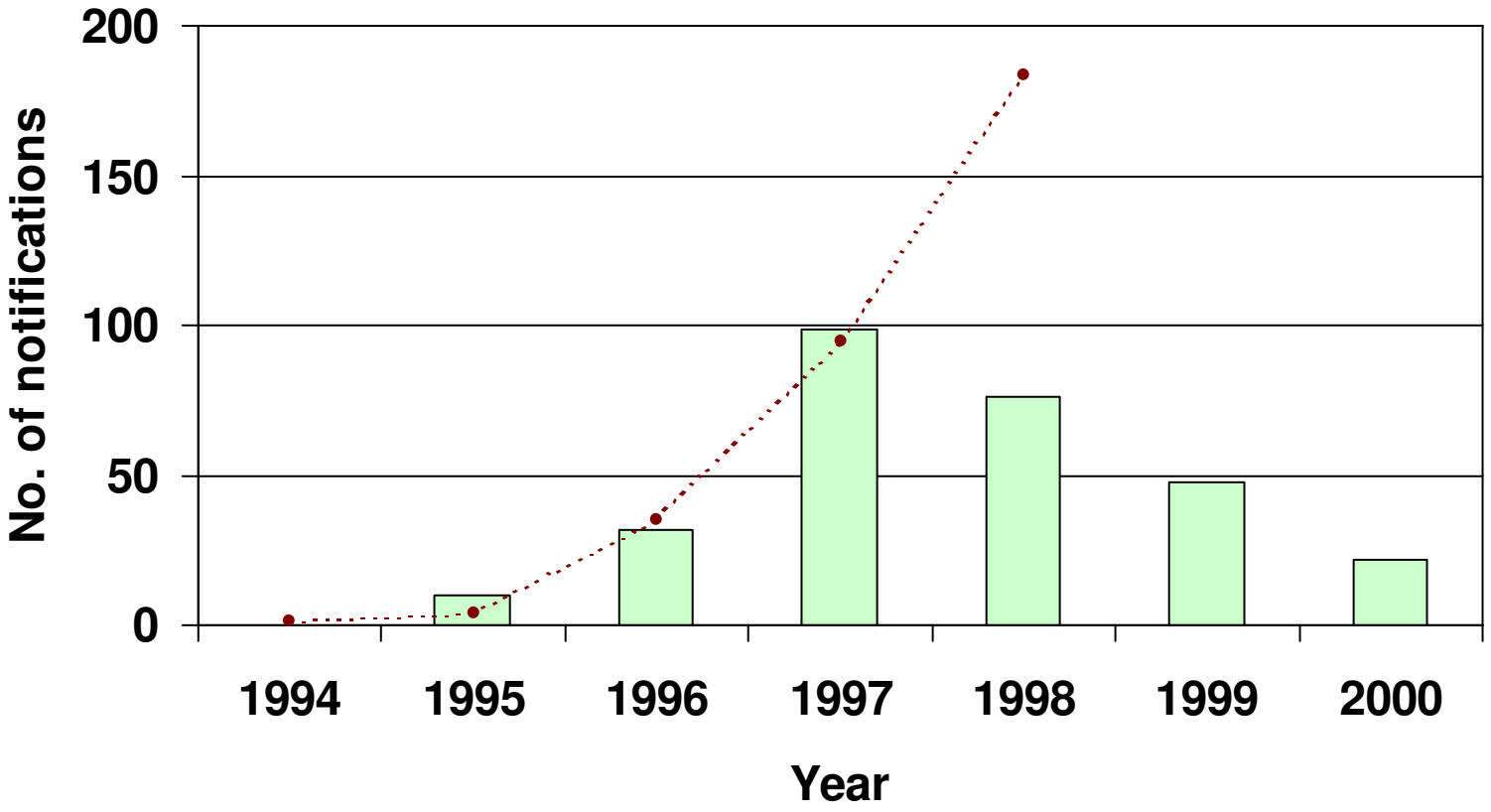
EU notifications of *Thrips palmi* on Thai orchids



Data source: EU FVO Office, Notifications of non compliance

Examples of resources and tools used in PRA - Establishment

- Resources
  - Climatic datasets
  - Hosts distribution data
- Tools
  - CLIMEX
  - Geographic Information Systems (GIS)
- Example
  - *Diabrotica virgifera virgifera*

Factors determining the Probability of Establishment

- Ecological Factors
  - Suitability of the abiotic environment, e.g. climate
  - Presence of suitable hosts, alternate hosts and vectors
  - Natural or artificial control mechanisms
  - Cultural practices

- Intrinsic Factors
  - The pest's reproductive strategy
  - Genetic adaptability
  - Minimum population needed for establishment

Diabrotica virgifera virgifera
Western corn rootworm

- Serious maize pest in northern USA and Canada
- In central Europe since 1992, August 2002 arrived near Paris
- Since first introduced into Europe, UK area of maize has risen markedly (now >100,000 ha/year)

Image sources: adult) USDA-ARS, CAB International Crop Protection Compendium, 2002
larva) CIMMYT, CAB International Crop Protection Compendium, 2002

Root damage by *D. virgifera virgifera* larvae

Source: **http://www.agron.missouri.edu/cgi-bin/sybgw_mdb/mdb3/Species/99186**

Establishment potential

- The geographic distribution and abundance of an organism that cannot control or regulate its body temperature is largely determined by climate.

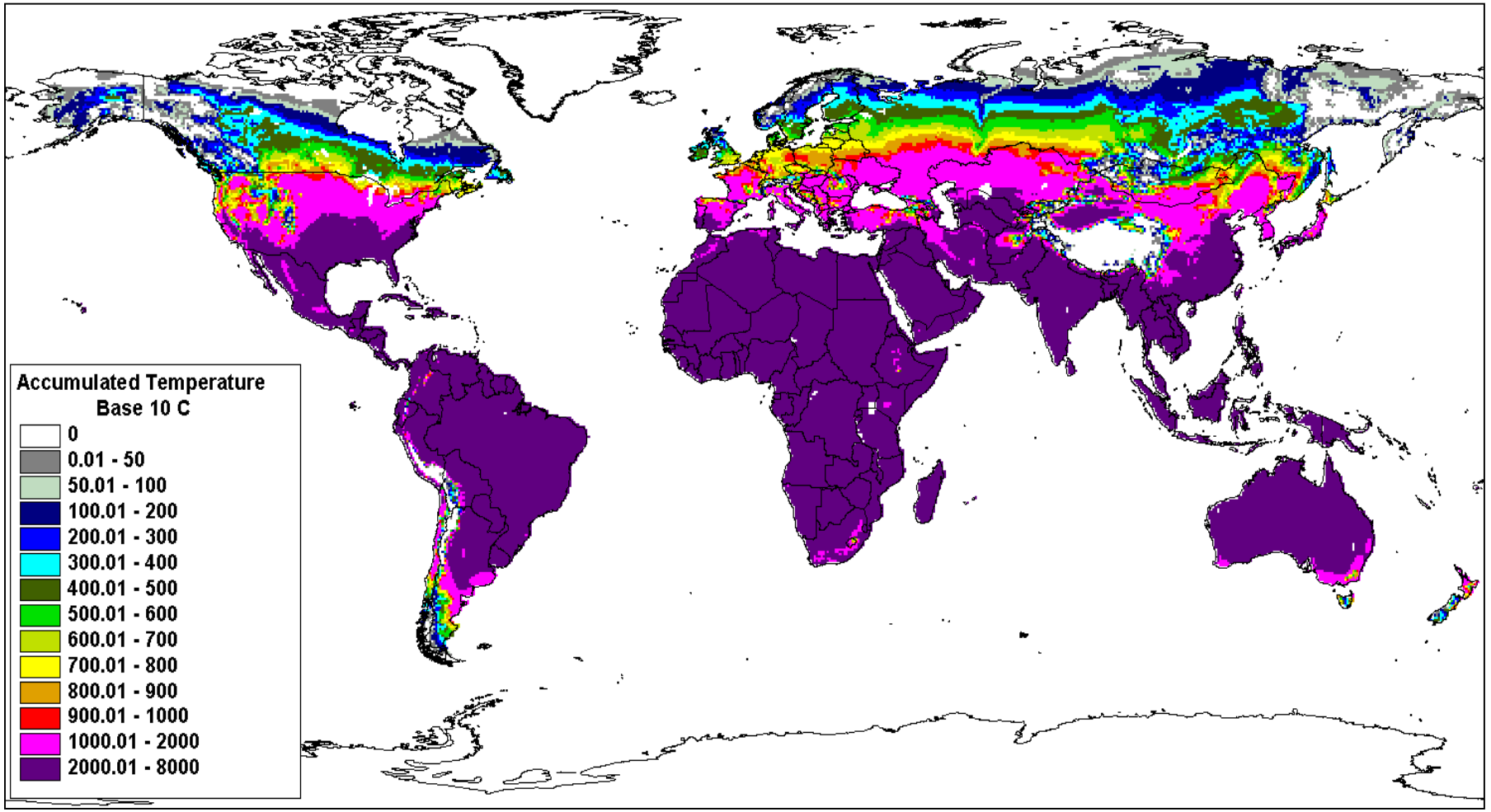
- Details of the climate from the known distribution of an organism can help predict the potential distribution and abundance of the organism in new geographic regions.

- Mapping the existing distribution of a pest and matching the climate within that area with similar climates elsewhere can help predict potential areas at risk.

World Annual Accumulated Temperatures base 10ºC for 1961-1990

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.

(Data from the Climatic Research Unit, Norwich)



CLIMEX - introduction

(www.ento.csiro.au/climex/climex.html)

- Computer software containing long term data (30 years) from almost 3,000 locations worldwide.
- Is used to predict the effects of climate on plants and animals based on biological parameters e.g. response to temperature.
- Generates a single number - the Eco-climatic Index to describe how favourable a location is for a particular species.

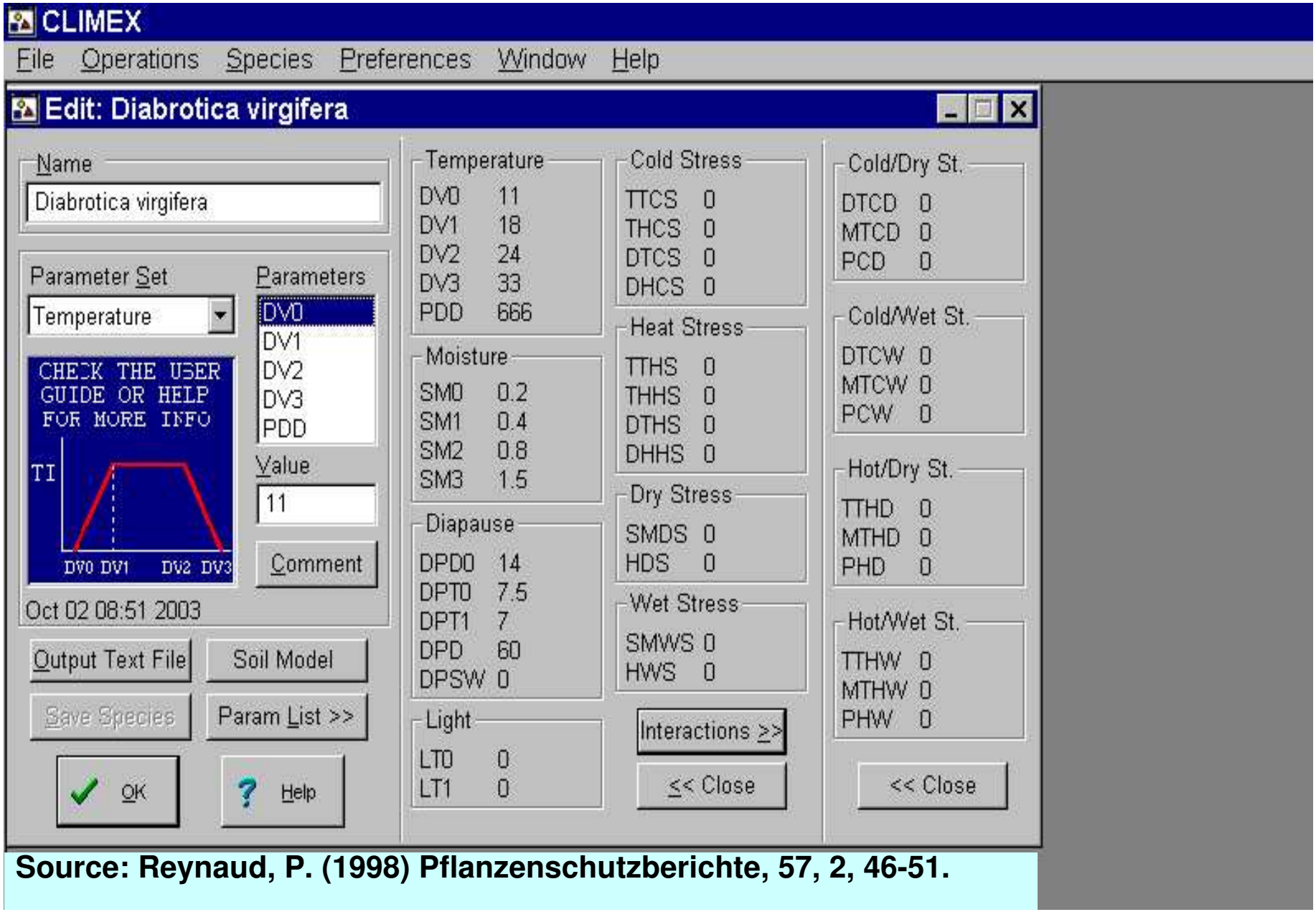
Diabrotica virgifera virgifera
Establishment and spread potential

- Apply CLIMEX
- Look at effects of climate change

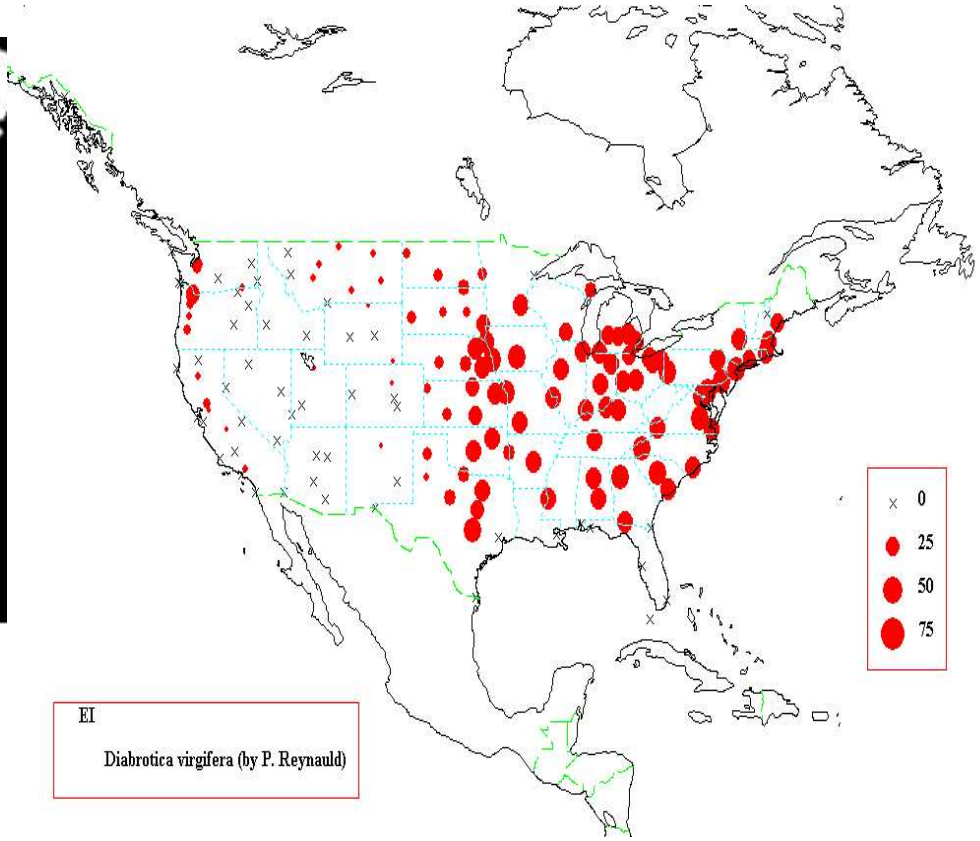
Current distribution of *Diabrotica virgifera virgifera* in the USA

Source: http://ipmworld.umn.edu/chapters/maize/ncr_map.GIF

Sample CLIMEX parameter entry screen

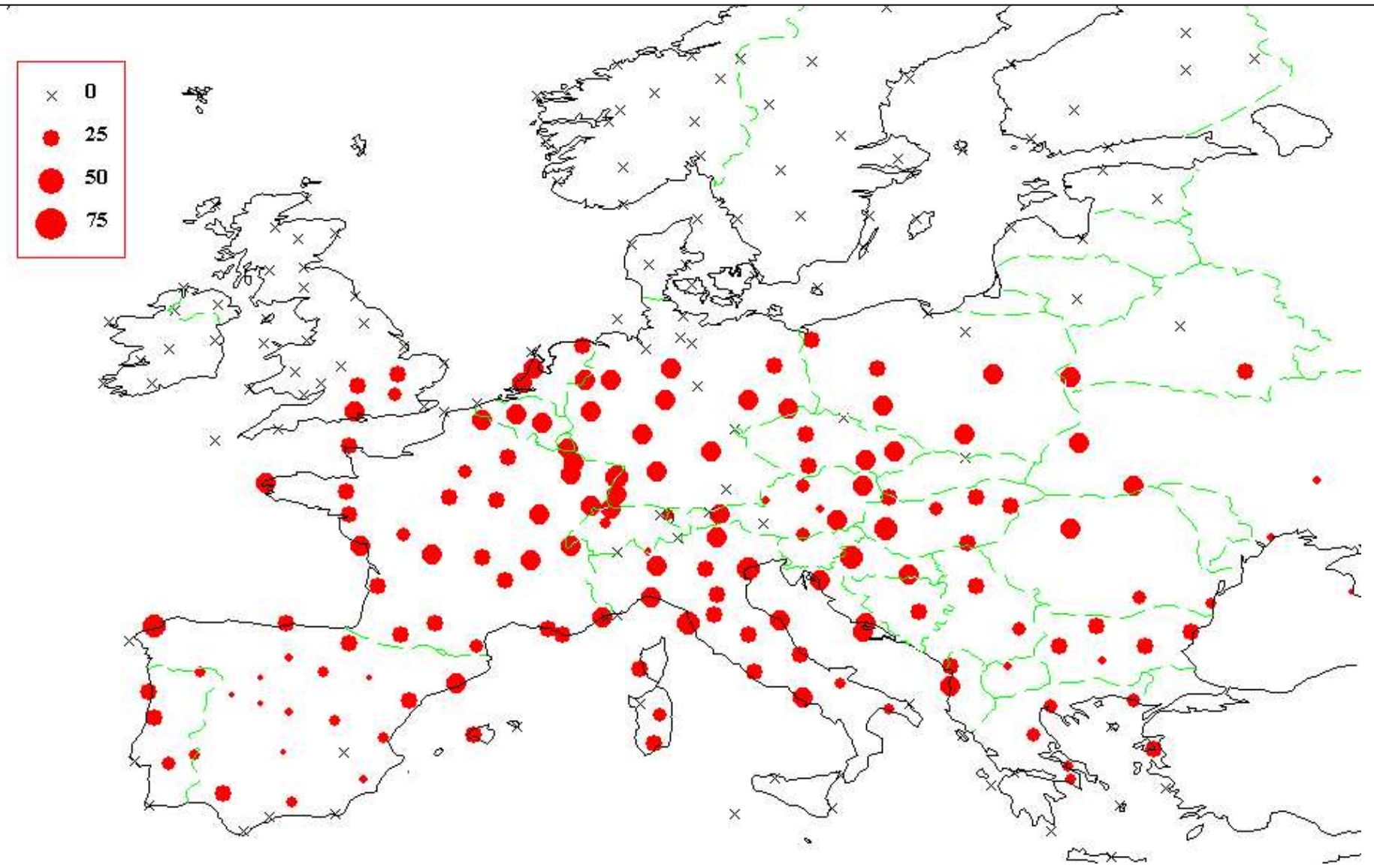


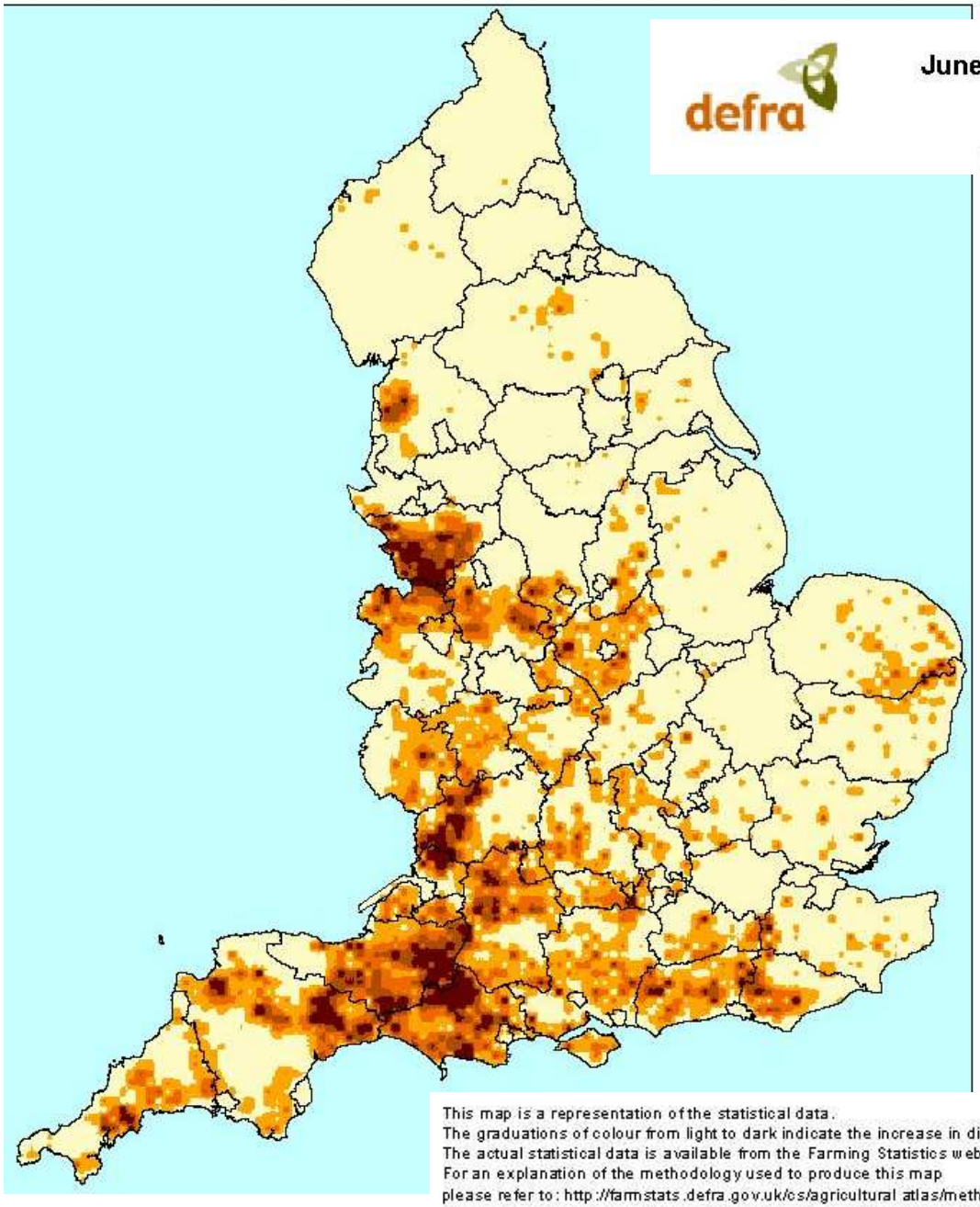
Source: Reynaud, P. (1998) Pflanzenschutzberichte, 57, 2, 46-51.



CLIMEX parameters for growth and environmental stress are estimated from *Diabrotica virgifera virgifera's* current distribution (above left) and used to generate ecoclimatic indices and a map of expected distribution in the USA (above right)

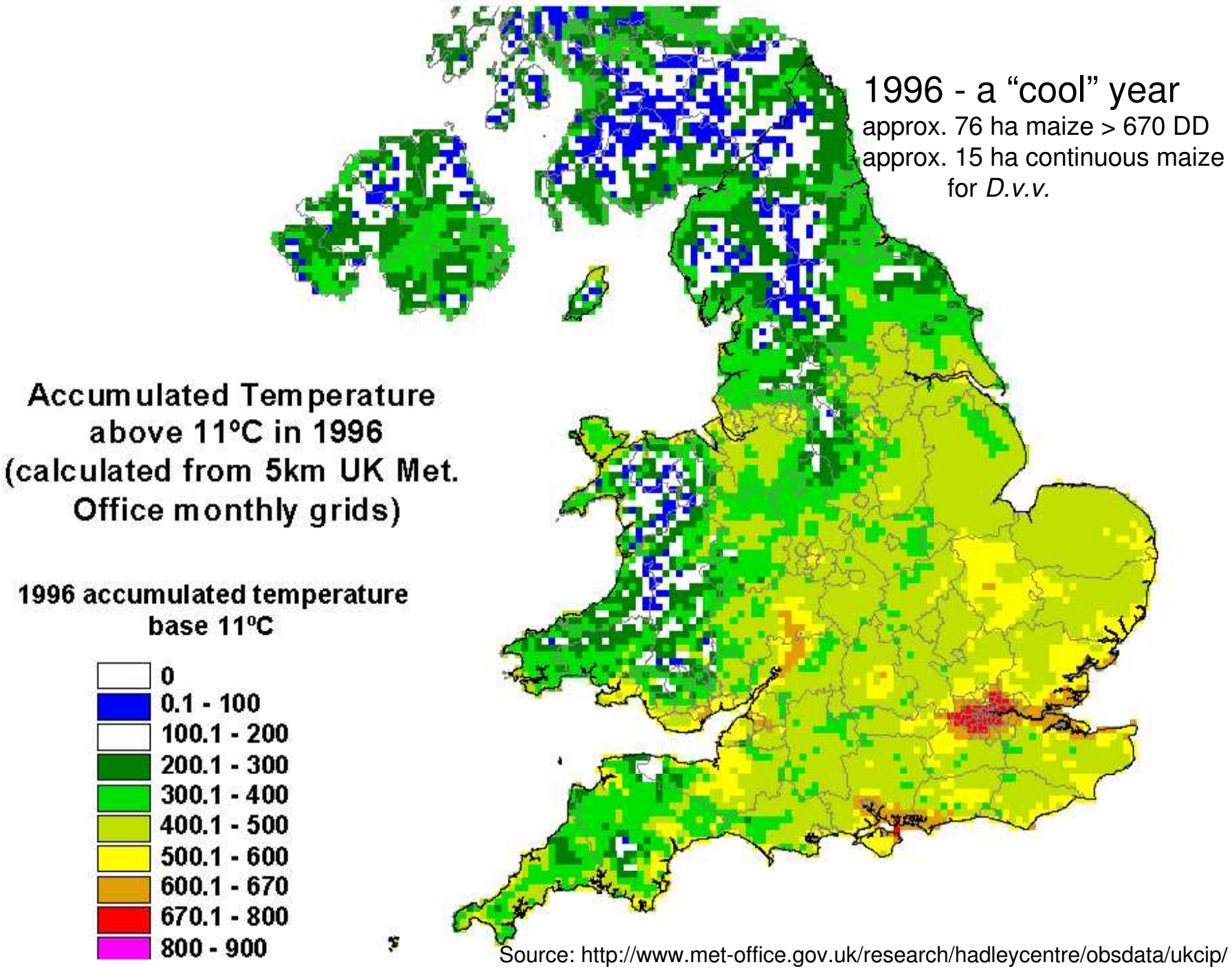
Diabrotica virgifera virgifera distribution in Europe:
predicted by CLIMEX with 1931-1960 mean climatic data from 285 weather stations

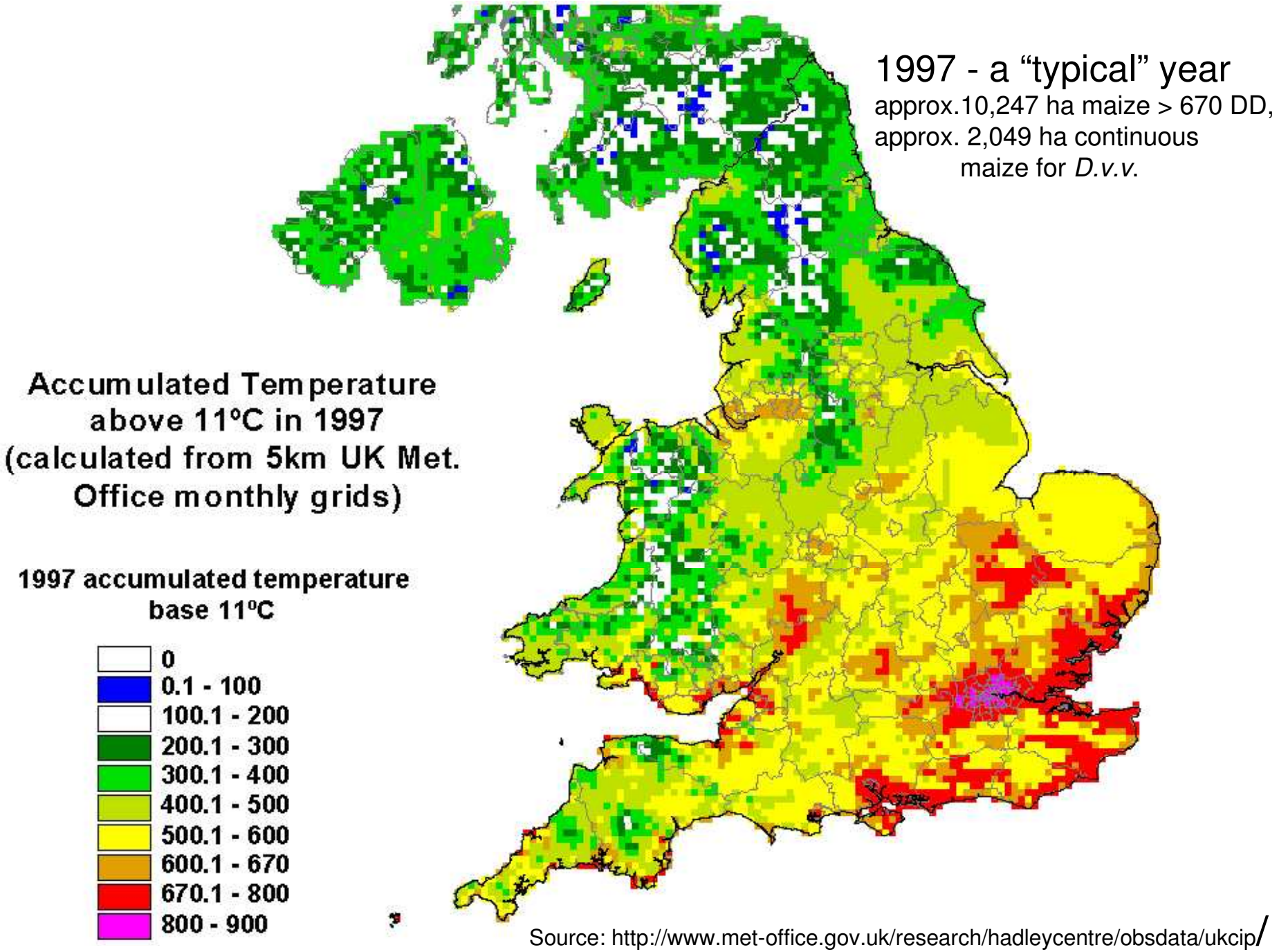


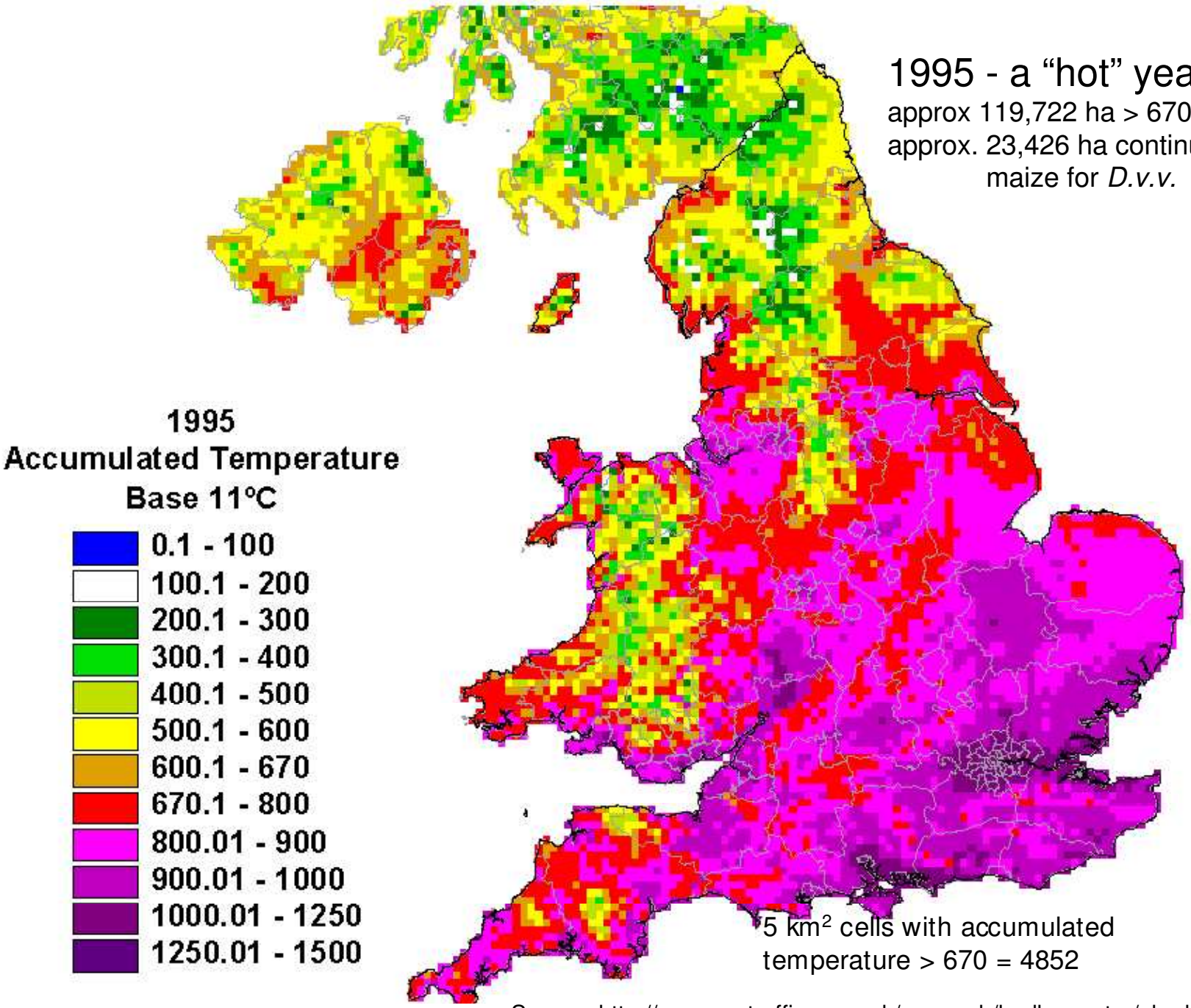


Distribution of maize in England

Source: http://farmstats.defra.gov.uk/cs/farmstats_data/MAPS/ agricultural_atlas/map_select.asp? year=2001&c_id=10&Submit3=Get+Map


1996 - a “cool” year
approx. 76 ha maize > 670 DD
approx. 15 ha continuous maize
for *D.v.v.*
Accumulated Temperature
above 11°C in 1996
(calculated from 5km UK Met.
Office monthly grids)
1996 accumulated temperature
base 11°C
0
0.1 - 100
100.1 - 200
200.1 - 300
300.1 - 400
400.1 - 500
500.1 - 600
600.1 - 670
670.1 - 800
800 - 900
Source: http://www.met-office.gov.uk/research/hadleycentre/obsdata/ukcip/


1997 - a “typical” year
approx.10,247 ha maize > 670 DD,
approx. 2,049 ha continuous
maize for *D.v.v.*
Accumulated Temperature
above 11°C in 1997
(calculated from 5km UK Met.
Office monthly grids)
1997 accumulated temperature
base 11°C
0
0.1 - 100
100.1 - 200
200.1 - 300
300.1 - 400
400.1 - 500
500.1 - 600
600.1 - 670
670.1 - 800
800 - 900
Source: http://www.met-office.gov.uk/research/hadleycentre/obsdata/ukcip/



1995 - a "hot" year

approx 119,722 ha > 670 DD

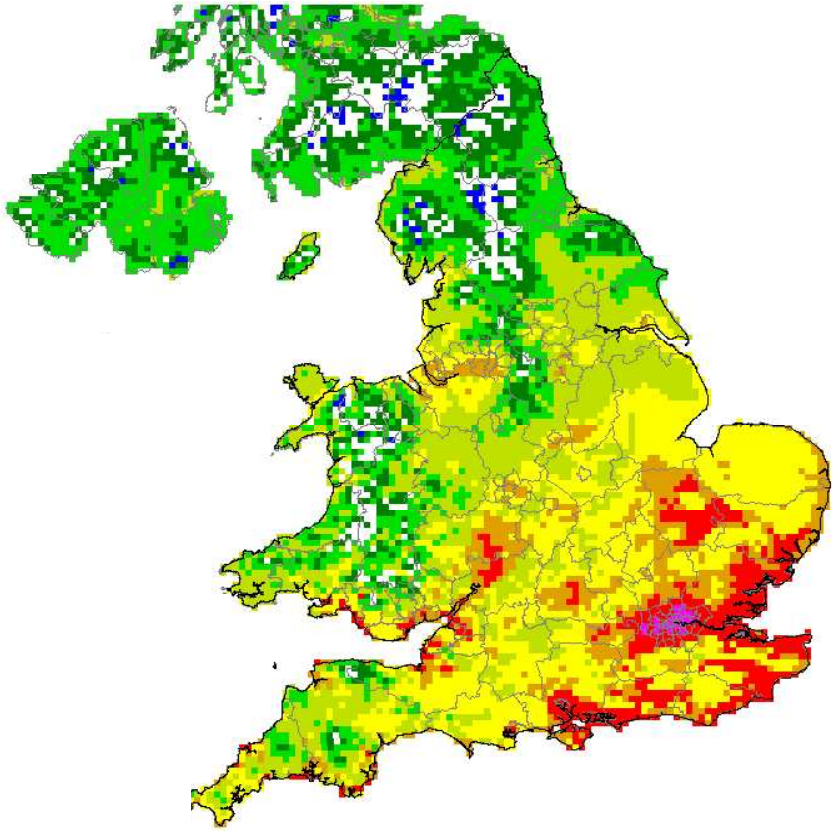
approx. 23,426 ha continuous maize for *D.v.v.*

5 km^2 cells with accumulated temperature > 670 = 4852

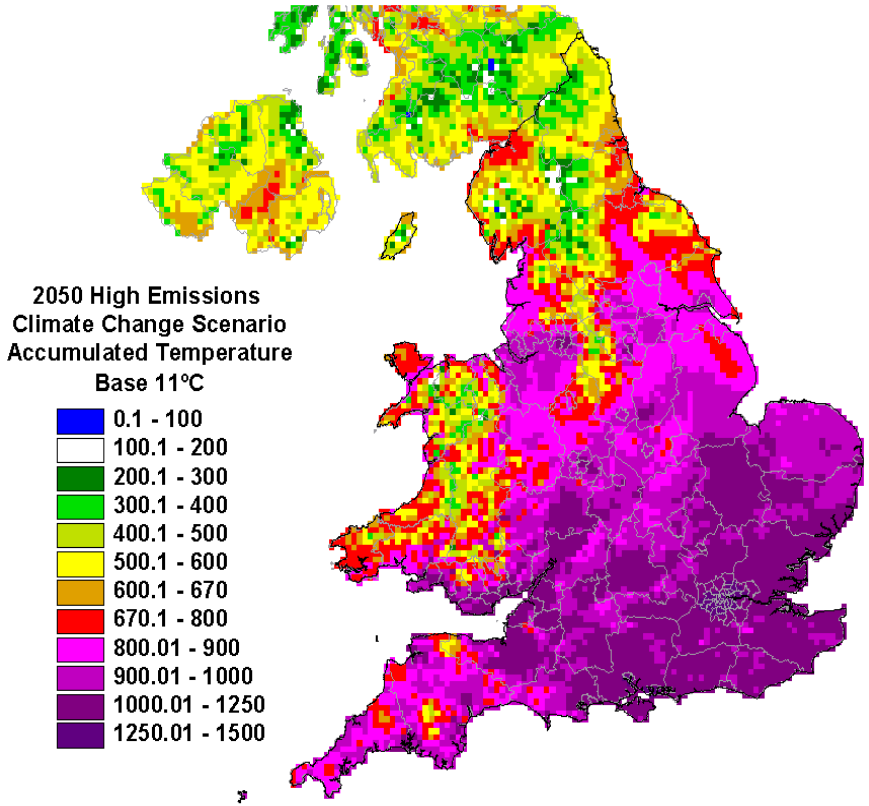
Source: http://www.met-office.gov.uk/research/hadleycentre/obsdata/ukcip/

Effect of Climate Change on the Area suitable for *Diabrotica virgifera virgifera* establishment

1997



2050



Source: http://www.ukcip.org.uk/scenarios/index.html

Diabrotica virgifera virgifera
Establishment conclusions

- *D. virgifera virgifera* is currently at the edge of its range of climatic suitability in the UK
- Climate change will have an increasing impact
- The area of maize grown under continuous rotation and control practices, e.g. presence of GM maize, will influence future impacts

Examples of resources and tools used in PRA - Economic impacts

- Resources
  - Biological data
  - Financial and Economic data
- Tools
  - Biological models
  - Financial and Economic models
    - Partial budgeting
    - Partial equilibrium analysis
- Example
  - *Bemisia tabaci*

Factors determining Economic Impacts

- Direct Pest Effects
  - Yield
  - Quality
  - Cost and Efficacy of Plant Protection
- Indirect Pest Effects
  - Market Access
  - Environmental Effects
  - Eradication, Research and Advisory costs
  - Social costs e.g. tourism

Bemisia tabaci
economic impact on tomato production

- Was a minor tropical pest of field crops
- In 1980s a new strain, resistant to many chemicals, & more polyphagous began to spread in trade.
- US estimates of $500m damage annually to field and protected crops (direct and virus damage)

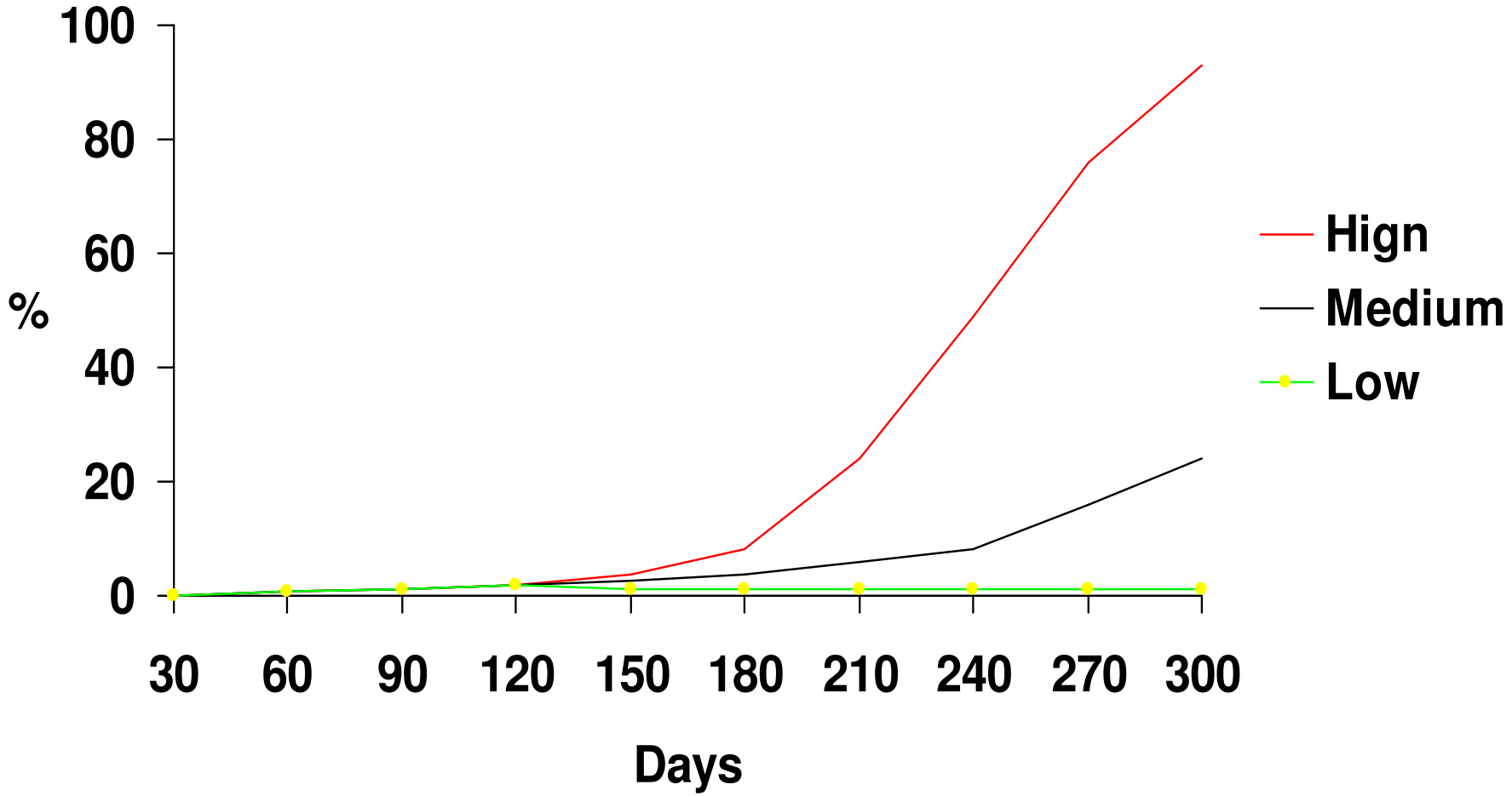
Gross margin budget: Tomatoes (0.1ha)

	£	£
Sales		30,280
Production costs	11,138	
Marketing costs	5,379	
Total variable costs		(16,517)
Gross Margin		13,763

Source: Anon (1994) An ADAS Management Budget for illustrative purposes, Tomatoes in Rockwool, December planting in the South East. In: *Gross Margin Budgets 1994, Glasshouse Crops*, ADAS.

% of tomato crop infested by TYLCV

Source: Morgan, D. & MacLeod, A. (1996) Assessing the economic threat of *Bemisia tabaci* (Gennadius) and tomato yellow leaf curl virus to the tomato industry in England and Wales, *BCPC*, 1996, 1077-1082.



Financial consequences (£/0.1ha)

	Standard £	Low £	Medium £	High £
Sales	30,280	29,952	28,403	22,611
Variable costs	(16,517)	(16,783)	(16,799)	(15,034)
Gross Margin	13,763	13,169	11,603	7,577
£ lost	£ 0	£ 595	£ 2,161	£ 6,187
% lost	0 %	4.3 %	15.7 %	44.9 %

Source: Morgan, D. & MacLeod, A. (1996) Assessing the economic threat of *Bemisia tabaci* (Gennadius) and tomato yellow leaf curl virus to the tomato industry in England and Wales, *BCPC*, 1996, 1077-1082.

Examples of resources and tools used in PRA - Environmental impacts

- Resources
  - Host distribution maps
  - Special areas of conservation
- Tools
  - GIS
- Example
  - *Phytophthora ramorum*

Distribution of Sudden Oak Death In USA

A range of symptoms can occur with *P. ramorum* infection: tree death has not been recorded in Europe

Leaf blight on *Leucothoe*

Leaf blight and die back on *Pieris*

Factors influencing the impact of *P. ramorum* in the UK

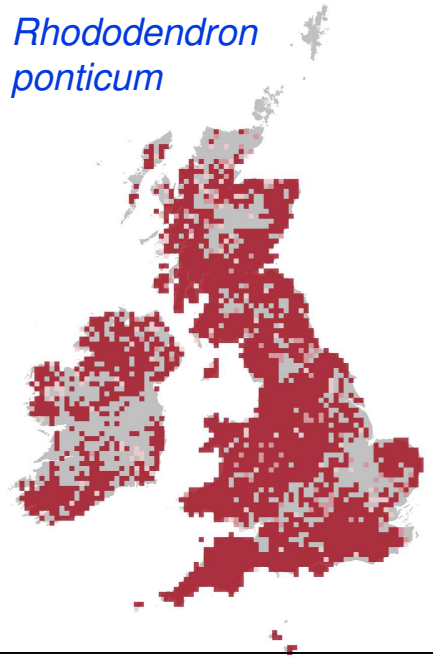
- Proximity to known evergreen hosts
  - *Rhododendron*, *Vaccinium* (Bilberry)
- Ecological importance of the host species
- Proximity to a nursery with infected plants and presence in parks and gardens

Distribution of the Principal Wild Hosts Of *Phytophthora ramorum* in the British Isles

from the New Atlas of the British And Irish Flora 2002

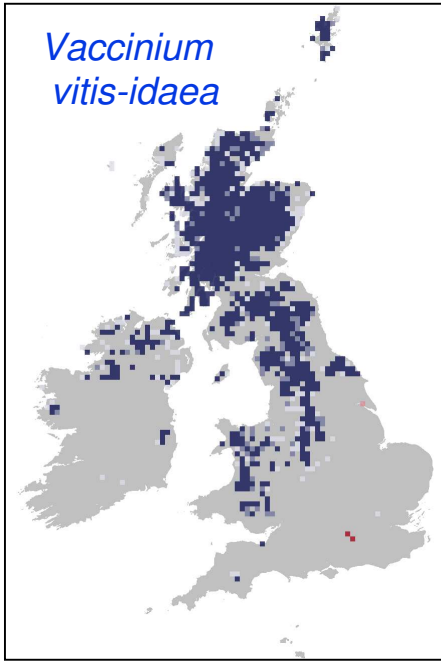
- 1987-1999 Native
- 1970-1986 Native
- Pre-1970 Native
- 1987-1999 Alien
- 1970-1986 Alien
- Pre-1970 Alien
- Other squares

Rhododendron ponticum

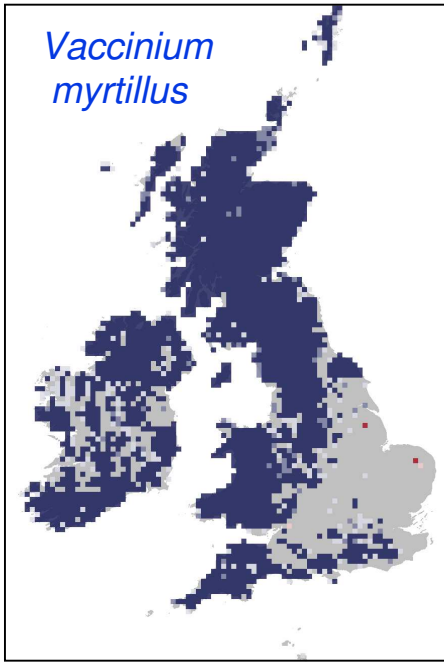


Viburnum tinus

Vaccinium vitis-idaea



Vaccinium myrtillus



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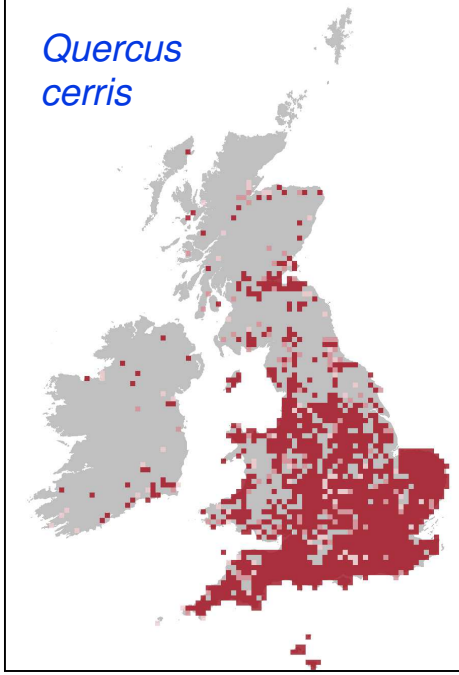
ENVIRONMENT AND HERITAGE SERVICE

Distribution of the main native and alien *Quercus* spp. in the British Isles

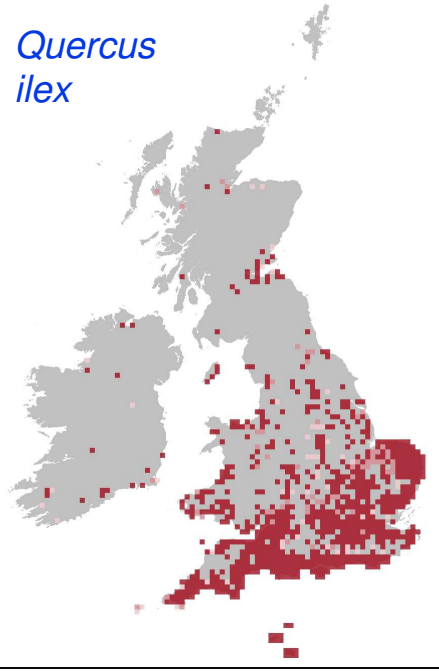
from the New Atlas of the British
And Irish Flora 2002

1987-1999 Native
1970-1986 Native
Pre-1970 Native
1987-1999 Alien
1970-1986 Alien
Pre-1970 Alien
Other squares

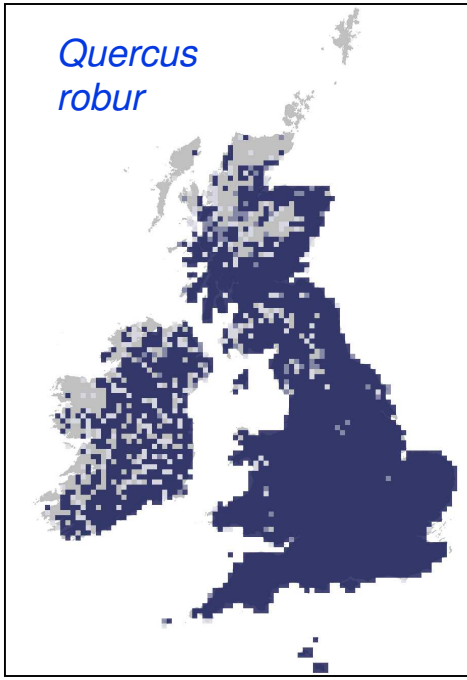
Quercus cerris



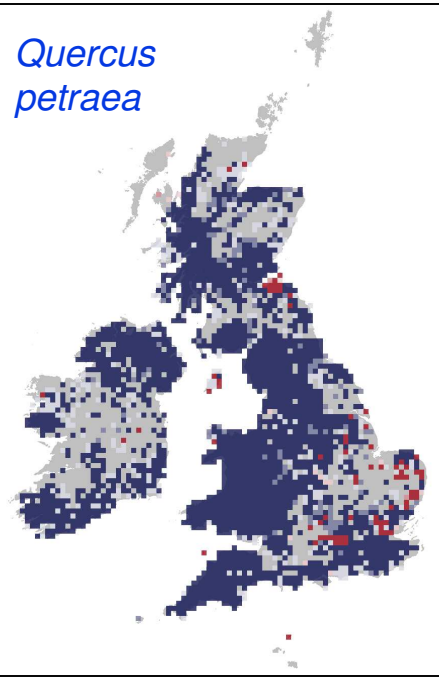
Quercus ilex



Quercus robur



Quercus petraea



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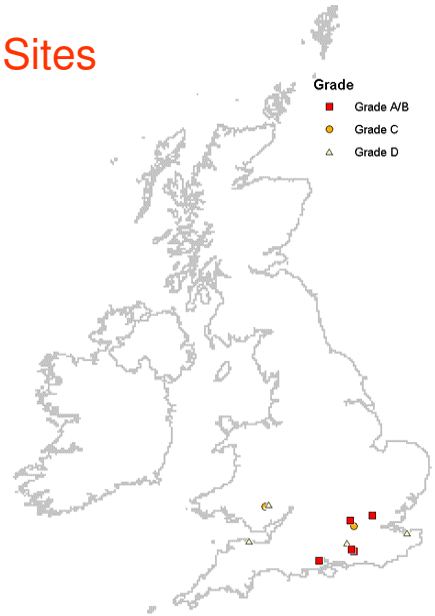
SAC* Habitat Woodland with Oak, Beech, *Rhododendron* and *Vaccinium* (*P. ramorum* hosts)

- Atlantic acidophilous beech Forests
  - e.g. New Forest, Burnham Beeches
- Old sessile oakwoods
  - e.g. South Dartmoor Woods, Borrowdale

* Special Areas of Conservation selected to conserve habitats listed in the EC Habitats Directive

Atlantic Acidophilous Beech Forests

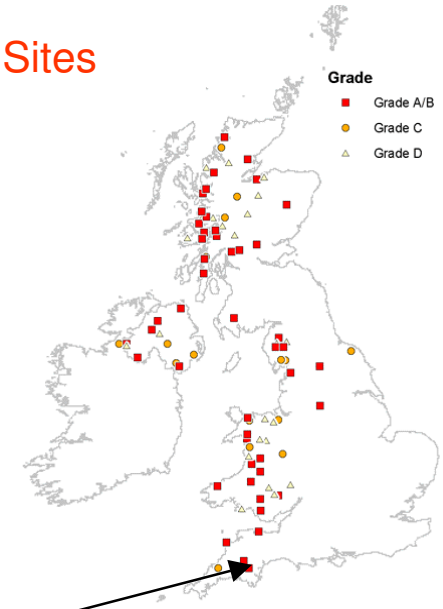
SAC Sites



UK Distribution

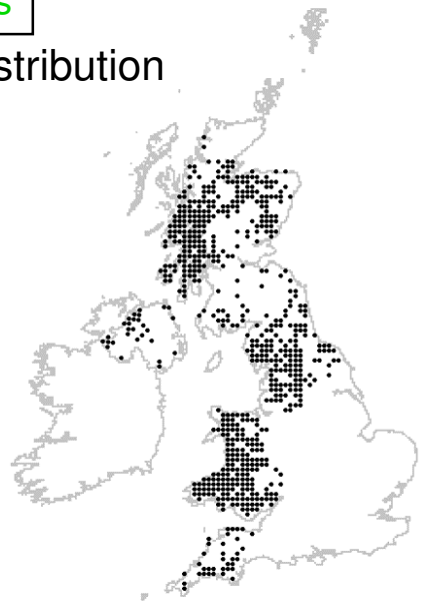
Old Sessile Oakwoods

SAC Sites



South Dartmoor Woods

UK Distribution



Source: http://www.english-nature.org.uk/pubs/gis/GIS_register.asp

Conclusions for Sudden Oak Death risk

- Nurseries with infection and susceptible hosts are widespread in the UK (although at low incidence)
- *Rhododendron* and *Vaccinium* occur on acid soils, especially where there is high rainfall
- Beech and oak are dominant in several woodland habitats where these hosts occur
- These woodlands include designated UK Special Areas of Conservation

PRA Tools & Resources: Conclusions

- There are many useful tools and resources which can assist in all stages of PRA production
- Logically, ISPM 11 could be accompanied by a manual describing what is available
- The development of the tools and the enhancement of the resources available for PRA needs to intensified

PRA Tools & Resources : Some Key Challenges for the Future

- Entry
  - Access to detailed trade pathway data
- Establishment
  - Increasing the spatial and temporal resolution of risk maps
- Spread
  - Enhancing spread models
- Impacts
  - Scaling up from one holding to many
  - Modelling changes in impacts over time
  - Quantifying environmental impacts
- General
  - From national to regional risk assessments
  - Quality control and publication
  - Form an international network of PRA practitioners?

Acknowledgements

- Thanks are due to
  - CAB International
  - CSL management
  - EU FVO Plant Health Control Unit
  - Plant Health Division (Defra)
  - the Plant Health and Seeds Inspectorate (Defra)