

# Climate Change and Tree Health

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- **Assume classic UKCIP scenario: ca 3°C warming in 50-80 yrs; warmer winters/summers; increased winter rain and summer drought; perturbances**
- **Will consider primarily pathogens and pests**
- **Structure of talk :**
  - **‘Generalisations’**
  - **Case study**
  - **Conclusions**

**Generalisations -**

**In Theory - climate change i.e. temperature, moisture, radiation levels - will have a direct effect on three main factors:**

- **Pathogen (pest) activity: numbers, fitness = pathogen aggressiveness.**
- **Host activity - numbers, vigour, stress levels = host resistance.**
- **Host - pathogen interaction.**

# But how easy to model or predict these effects?

## **Effect on pathogen (pest) activity:**

Easier to predict if pathogen's response to temperature, moisture is well documented

## **Effect on host activity:**

Might be predicted where host ecophysiology and resistance mechanisms are well documented

## **Effect on host - pathogen interaction:**

Difficult to predict - very complex area

## In Practice:

### **Effect on pathogen (pest) activity:**

- data often too limited to model effectively (one example later)
- little info on pathogen potential to adapt

### **Effect on host activity:**

- data often too limited to model effectively

### **Effect on the host - pathogen interaction:**

- too little data - area of great uncertainty

Also – need to include effect on local ecosystem

- too complex to predict!

# Different climate change impact on native *vs* introduced host and pathogen systems?

## Native woodland hosts and native pathogen/pest

- Co-evolved system
- Better ecologically buffered
- System more stable under climatic pressure?

## Introduced plantation hosts and native pathogen/pest

- Non co-evolved system
- Host already out of proper ecological context
- System more *unstable* under climatic pressure?

# Native/introduced host and invasive pathogen/pest

- Non co-evolved system
- Host and pathogen both out of ecological context
- Host and pathogen often seriously out of balance
- Pests and pathogens lack natural enemies
- Epidemics . . .

egs. Epidemics of DED, chestnut blight, pinewood nematode, *Phytophthora ramorum* (SOD), alder *Phytophthora*, *P. cinnamomi*, red band needle blight, green spruce aphid, great spruce bark beetle, Asian longhorn beetle...

- System potentially most *unstable* under climatic pressure?



## Add to this -

The fact that the frequency of invasion by non-native pests and pathogens appears to be increasing -

– And we are likely to see *interaction* between two major environmental issues:

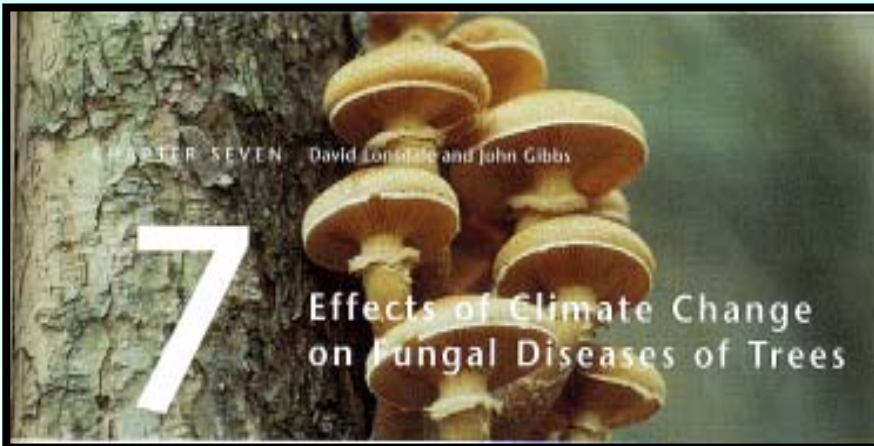
Climate change and Invasive pathogens.

- This could compound the risk to our forests and natural ecosystems.

**Due to:**

- the complexity of the underlying processes
- the paucity of good predictive scientific data

**Literature overviews on this issue deal mainly in generalities, stressing the uncertainties**



*Bulletin OEPP/EPPO Bulletin 24, 221–232 (1994)*

**European oak declines and global warming: a theoretical assessment with special reference to the activity of *Phytophthora cinnamomi***

by C. M. BRASIER and J. K. SCOTT\*

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# Examples of general points made re the classic climate change scenario (- see published reviews for details)

- Less winter cold injury but more autumn forest injury
- Increased drought stress  $\Rightarrow$  increased attack by opportunists e.g. Honey fungus (*Armilliara*)
- Increased drought stress  $\Rightarrow$  more fatalities from root pathogens such as *Phytophthora*
- Increase in oak and beech declines
- More attack by winter active diebacks and stem cankers (because asynchronous dormancy zone or ADZ will move northwards)

- Increase in foliar diseases needing warm wet springs for infection e.g. red band needle blight of Corsican pine
- Increased flooding will enhance infection by *Phytophthora* pathogens eg Alder *Phytophthora* on rivers
- Stress and disease will open canopy structure  $\Rightarrow$  more stress and disease
- High temperature pathogens such as sooty bark disease of sycamore and *P. cinnamomi* will become more prevalent
- Northern ranges of insect pests and insect vectors likely to be extended
- Balance between insect pests and their natural enemies will be altered

- Development of green spruce aphid (*Elatobium*) likely to be favoured  $\Rightarrow$  decline in Sitka spruce production
- Insects overwintering as eggs or adults will benefit
- Conditions will favour spread in UK of exotic pests such as southern pine beetle (*Ips typographus*)
- New invasive pests will emerge (without more effective import controls)
- Increase in CO<sub>2</sub> will lead to decline in food quality (low N) for chewing insects

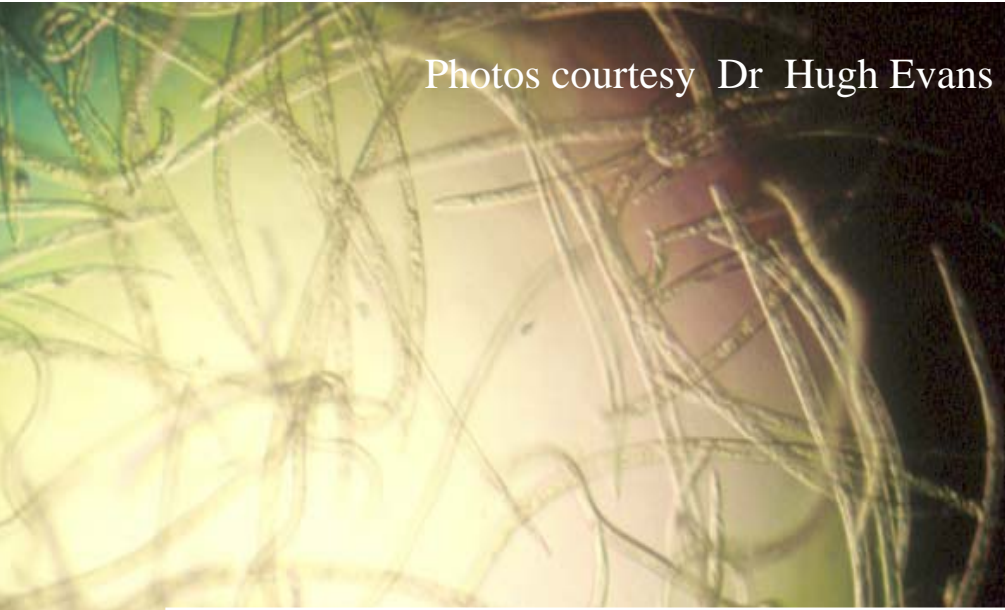
# Green spruce aphid (*Elatobium*) on Sitka spruce



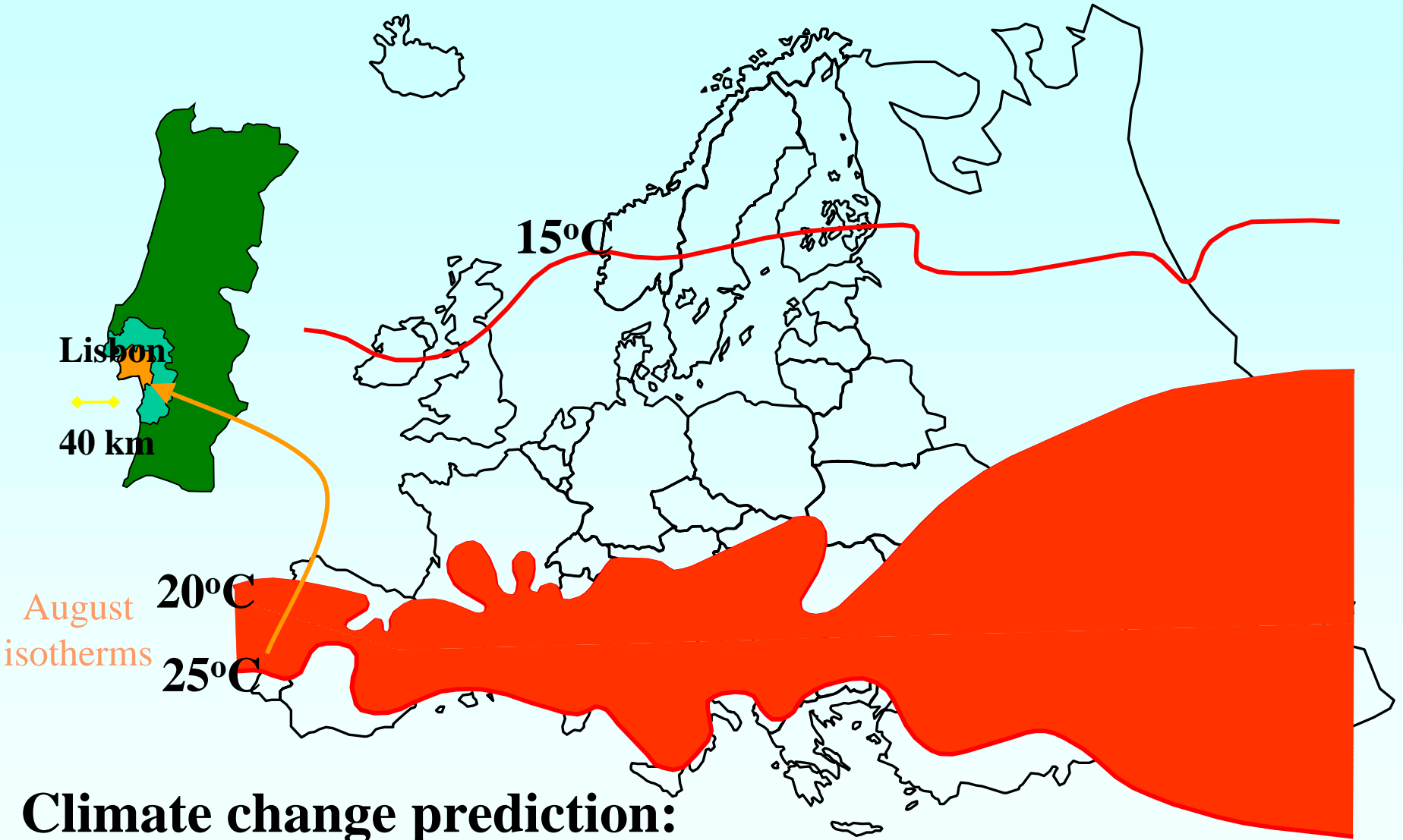
Photos courtesy Dr. Nigel Straw

# Pinewood nematode: *Bursaphelenchus xylophilus*

Photos courtesy Dr Hugh Evans



# Pinewood nematode: *Bursaphelenchus xylophilus*



**Climate change prediction:  
wilt expression will move northward  
severity will increase in the south**

Courtesy Dr. Hugh Evans



# Red band needle blight *Dothistroma pini*



Photos courtesy Dr. Anna Brown

# Red band needle blight *Dothistroma pini*



## **Is an unprecedented *Dothistroma* needle blight epidemic related to climate change?\***

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**Specific case study –**  
*Phytophthora cinnamomi*

*Phytophthora* pathogens:  
microscopic fungi (potato blight)

- require water for infection via swimming spores
- root diseases; stem diseases; foliar diseases
- drought after infection accelerates disease
- likely to benefit from climate change: warm winters + winter rain, summer drought, summer storms

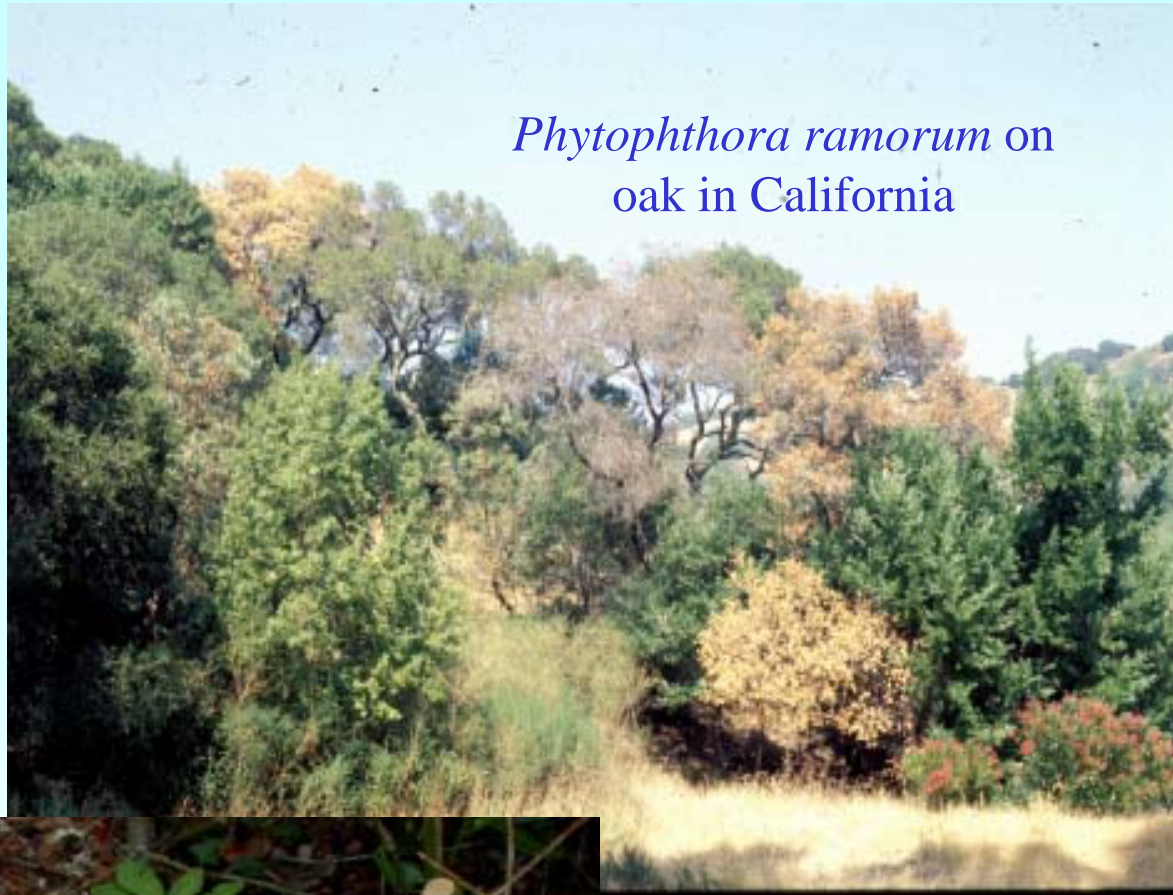
Current examples in UK: \**P. cambivora* on beech, \**P. ramorum* and \**P. kernoviae* (SOD) on beech, \**P. alni* on alder, \**P. ilicis* on holly, \**P. cinnamomi* on various hosts

\* All invasive *Phytophthoras*, all showing increased activity.

*Phytophthora*  
swimming  
spores



*Phytophthora ramorum* on  
oak in California



*Phytophthora kernoviae*  
on beech in UK

# *Phytophthora cinnamomi*:

**Collar and root rots – wide host range >1000 species**

**Probably native to PNG – Celebes**

**Invasive – spread world wide by plant trade since 1900s**

- epidemic on chestnuts SE USA 1940s (+ Spain, Portugal)
- now destroying world communities SW Australia (+ Fejnbos, South Africa)
- cause of current Cork oak mortality in Spain, Portugal
- affects chestnuts, yew, oaks and many other spp. in UK

**Needs rainwater for infection**

**Warm temps 25°C+ favour disease (Mediterranean)**



*Phytophthora cinnamomi* on oak (*Q. ilex*) in Spain

*P. cinnamomi* on chestnut in UK

# CLIMEX model

Predicted PC activity in Europe  
under normal conditions

(Brasier & Scott  
1994)

Dot size =  
climatic  
suitability



500k





Predicted PC activity in Europe assuming  
max and min temperature increase of 3°C

(Brasier & Scott  
1994)

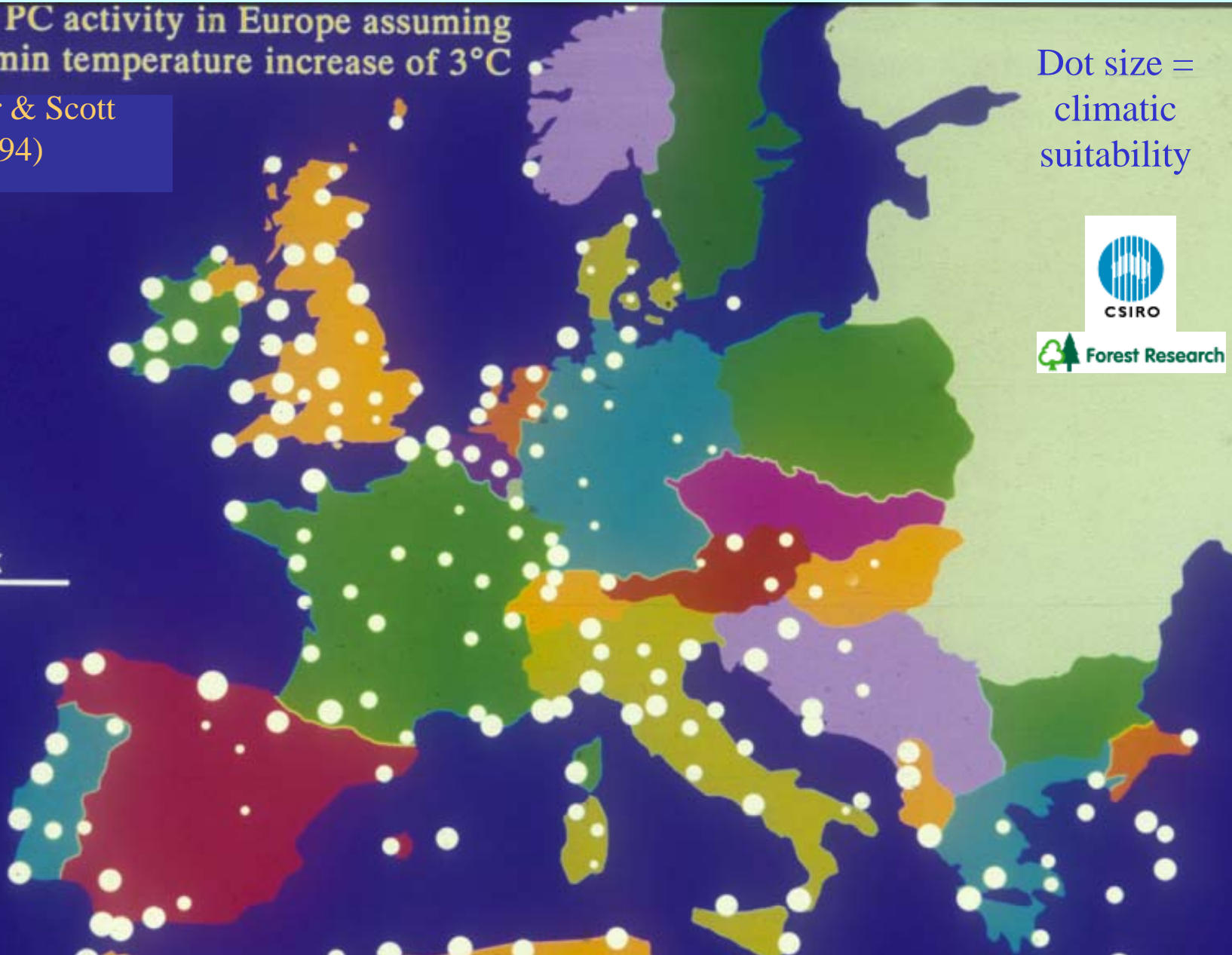
Dot size =  
climatic  
suitability



CSIRO



500k



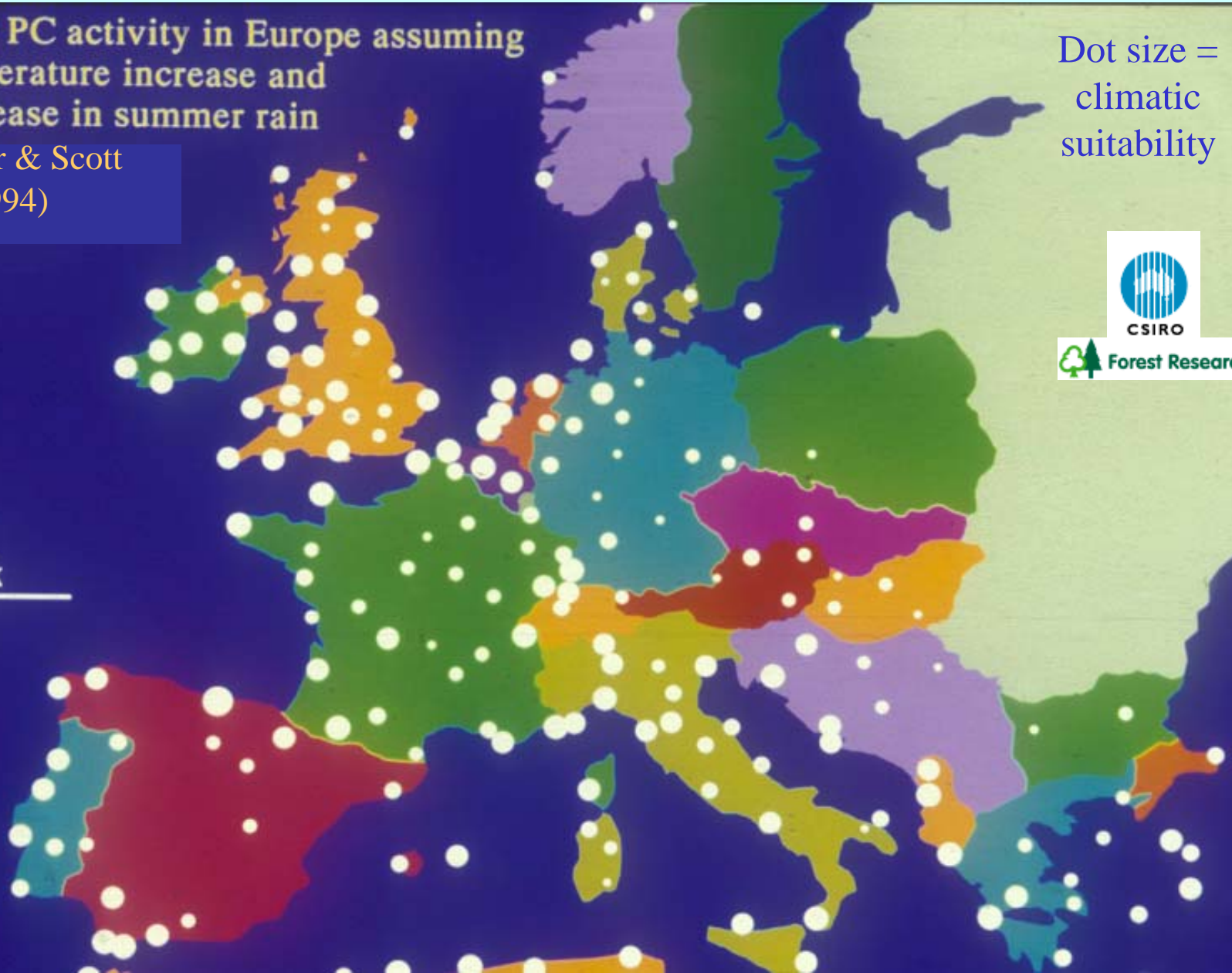
Predicted PC activity in Europe assuming  
3°C temperature increase and  
20% increase in summer rain

(Brasier & Scott  
1994)

Dot size =  
climatic  
suitability



500k



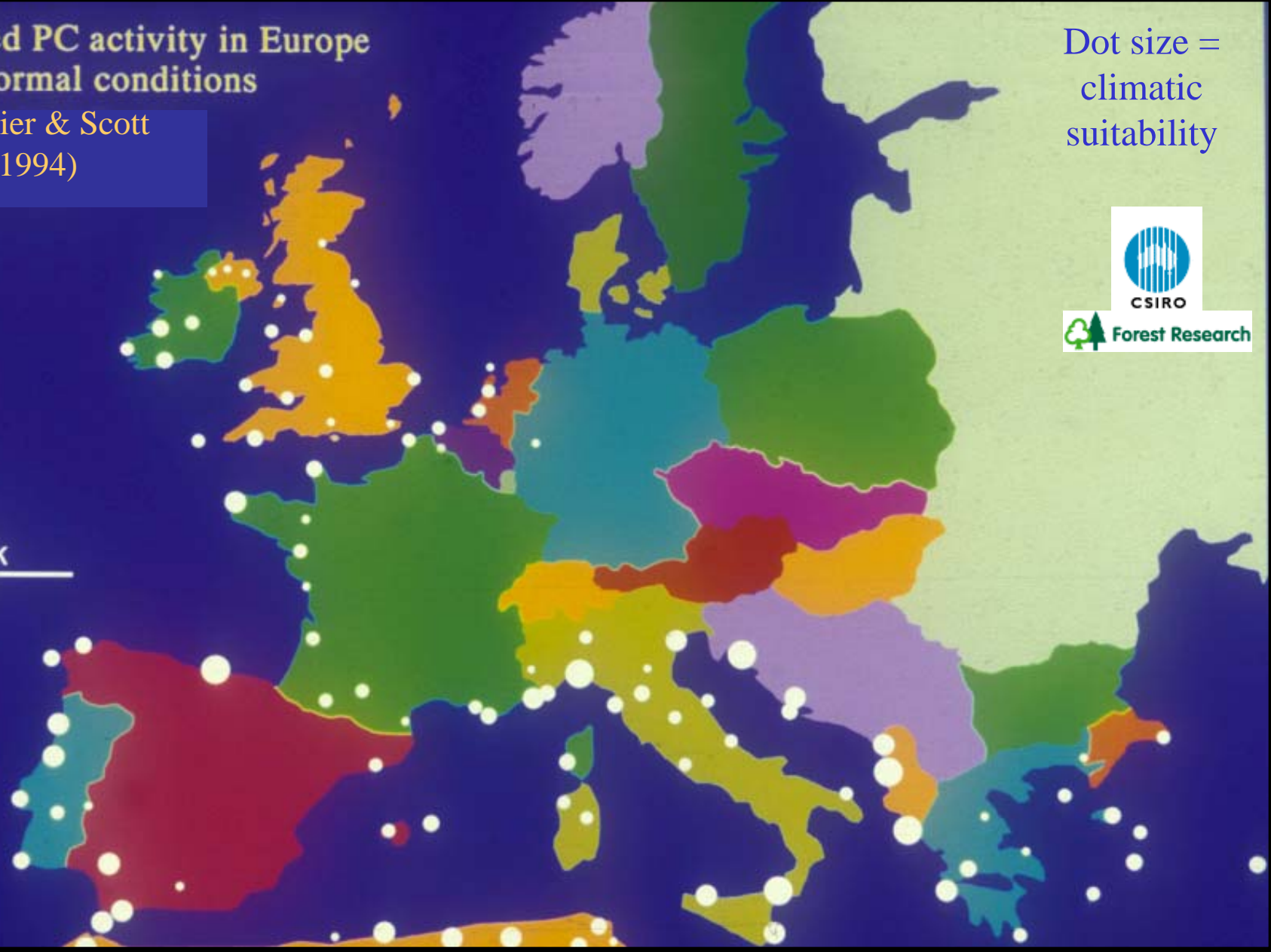
# Predicted PC activity in Europe under normal conditions

(Brasier & Scott 1994)

Dot size = climatic suitability



500k

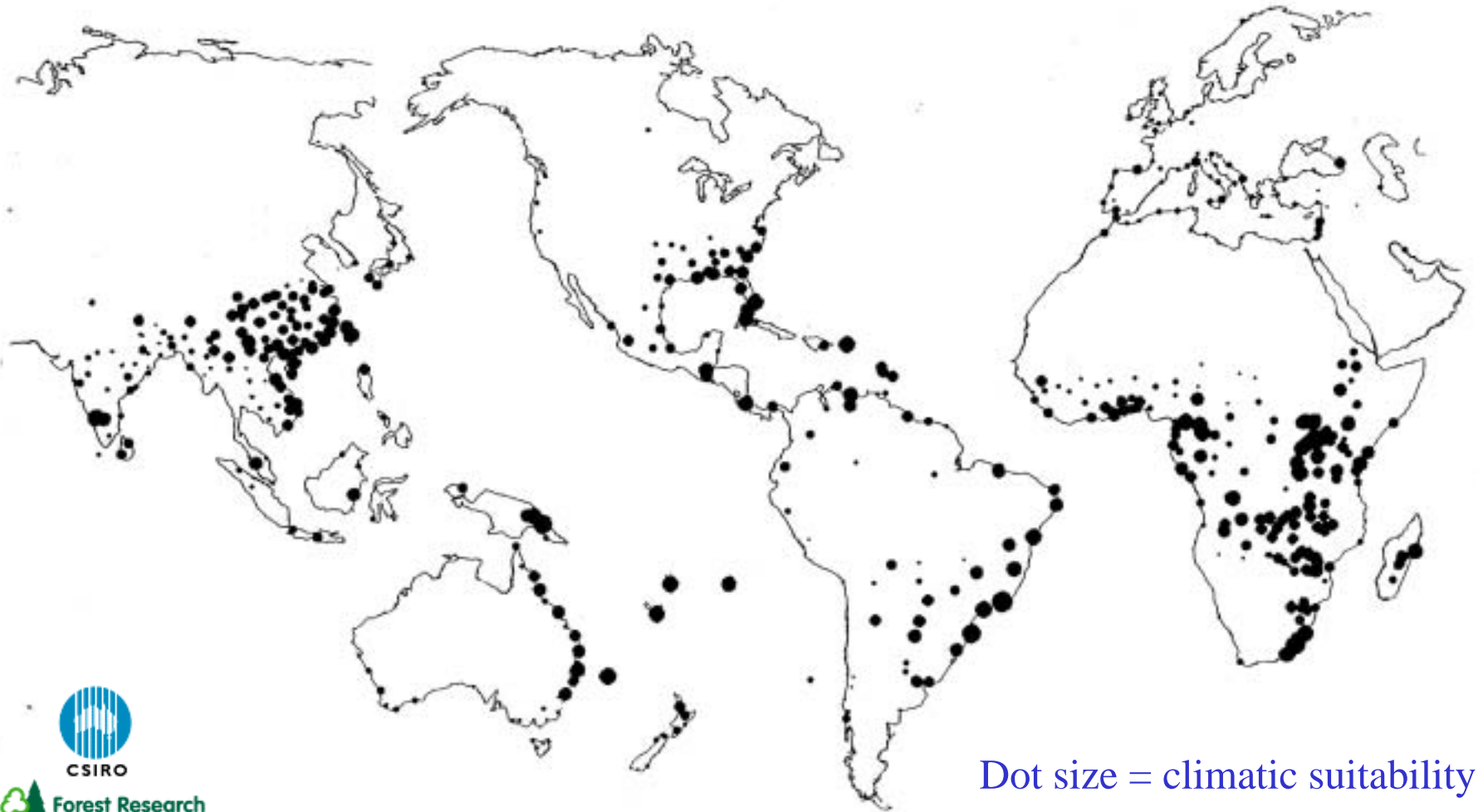


‘normal’ or current conditions

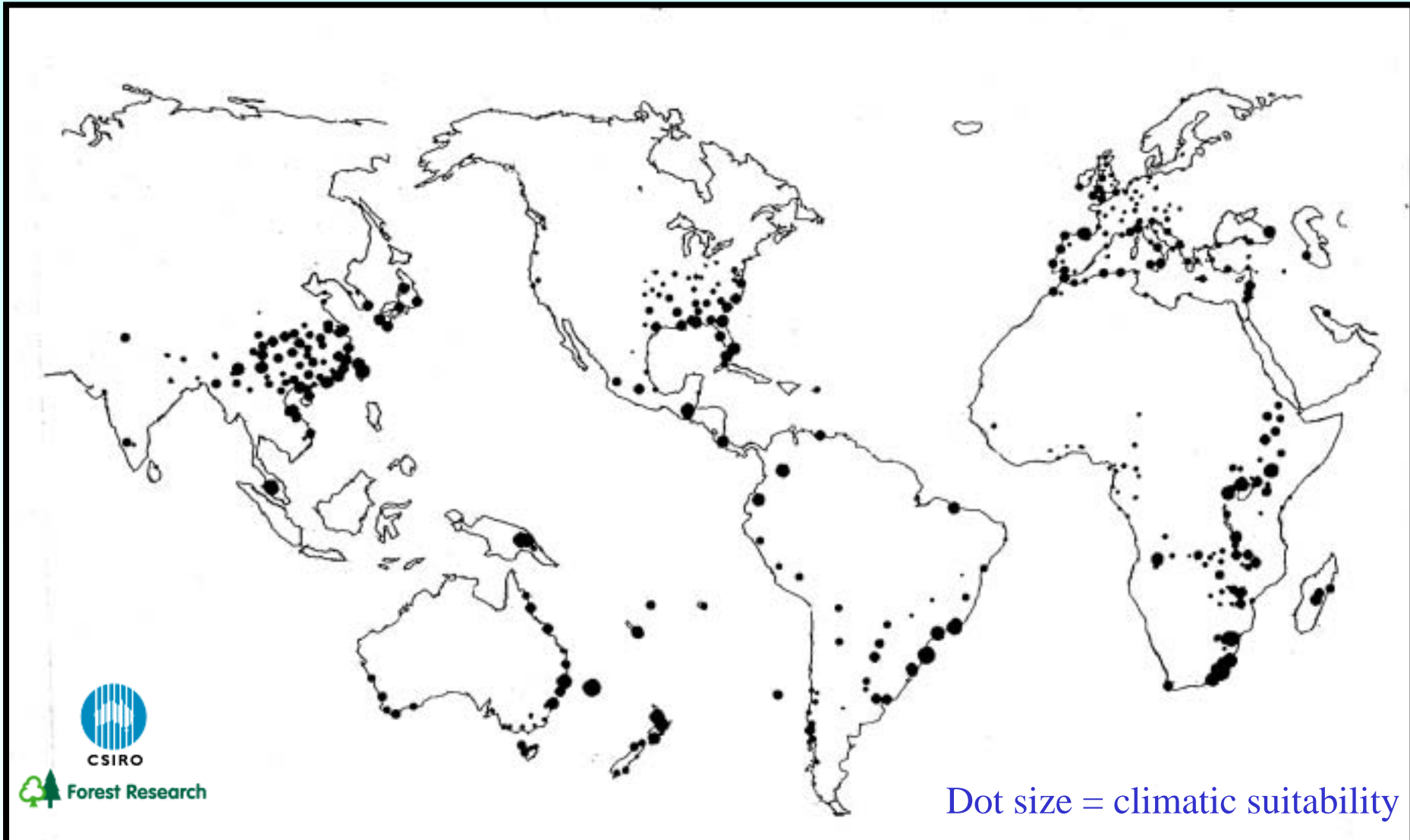


⇒ global scale

# Predicted world wide activity of *P. cinnamomi* under current climates (normal conditions)

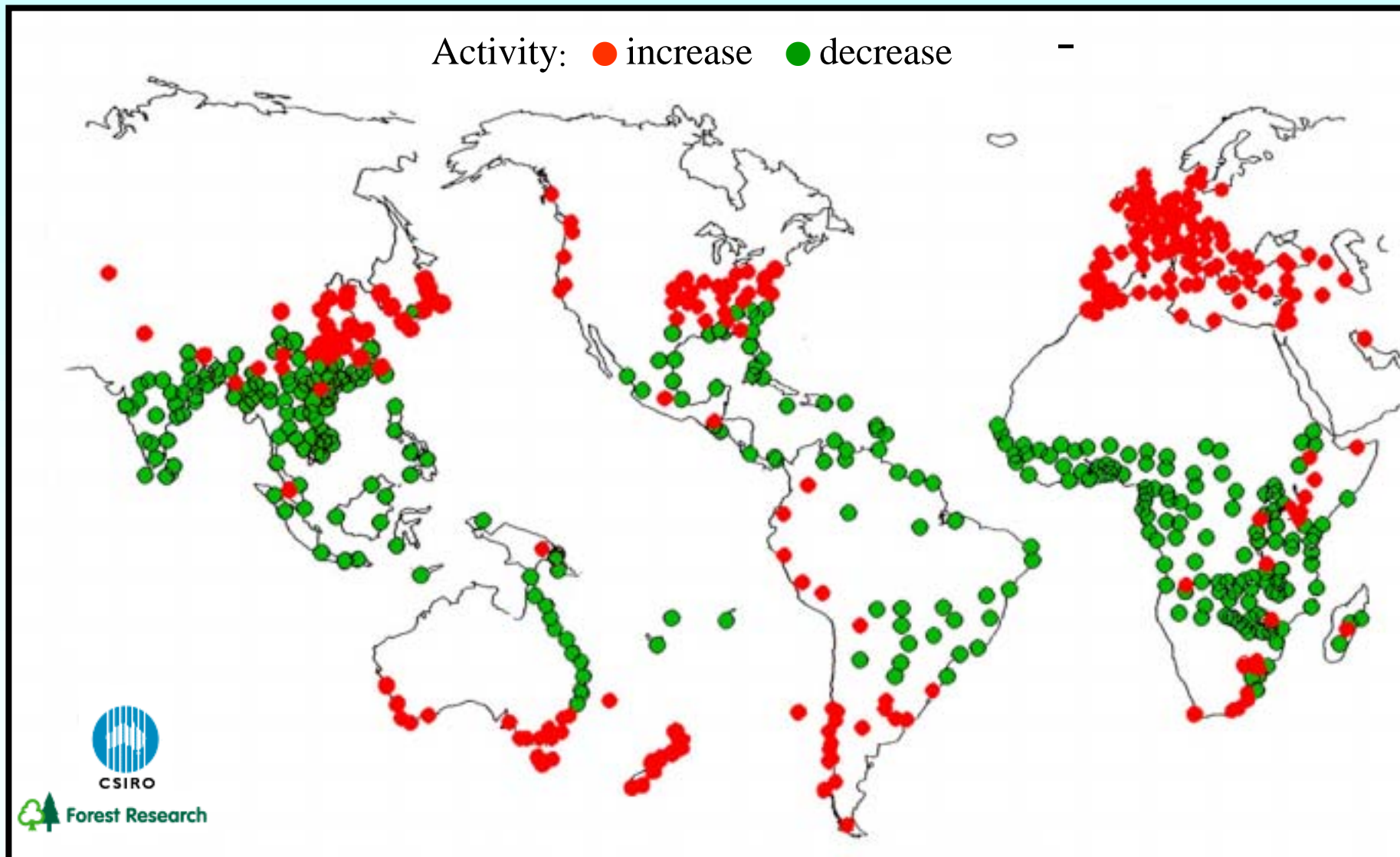


# Predicted world wide activity of *P. cinnamomi* assuming 3°C increase in mean annual temperatures



(From Brasier 2000. Data of J. Scott and C.M. Brasier)

# Predicted world wide activity of *P. cinnamomi*: contrast between current climates and a +3°C mean increase



(From Brasier 2000. Data of J. Scott and C.M. Brasier)

# Concluding comments



1. Climate change will be broadly detrimental to tree health and will favour some highly damaging pathogens
2. Climate change x non-native hosts or invasive pathogens: more unstable - higher risk
3. Prevent arrival of invasive pathogens - modernise and improve international (UK) plant health protocols

4. There is a case for planting native trees and encouraging native ecosystems assuming these systems -
  - often better ecologically buffered
  - often have a wider tree gene pool for adaptation
  
5. There is case for harnessing the enormous power of natural selection eg. by densely sowing seed material and allowing the 'new' environment to select out the fittest - or - optimal - tree phenotypes