Global approach to crop wild relative conservation:

Temperate Forage and Pulse Legume Genetic Gap Analysis

Nigel MAXTED, Serene HARGREAVES, Shelagh KELL, Álvaro Toledo, Ahmed AMRI, Ken STREET, Ali SHEHADEH, Josephine PIGGIN and Jan KONOPKA

UNIVERSITY OF BIRMINGHAM

ICARDA

Objectives of this presentation

- Approaches to crop wild relatives (CWR) conservation
- How to do genetic gap analysis?
- *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* diversity and priority species distribution + research a couple of research questions
- Necessary conservation actions for temperate legume diversity

Policy context

- CBD Strategic Plan agreed in Nagoya (2010) – Target 13 of 20!

"Target 13. By 2020, The status of crop and livestock genetic diversity in agricultural ecosystems and of wild relatives has been improved. (SMART target to be developed at global and national levels) …. In addition, *in situ* conservation of wild relatives of crop plants could be improved inside and outside protected areas."

- CBD Global Strategy for Plant Conservation 2011 – 2020 (2010)
  - Target 9 of 16

Target 9: 70 per cent of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge.

What are crop wild relatives?

- CWR defined by their characteristics
  - Species related to crops
  - Possible crop progenitors
  - Possible gene donors for crops
- In the 1920s Vavilov recognised the potential of CWR for crop improvement and CWR have been routinely used since the 1940s
- Any species in the same genus as the socio-economic crop
- More precisely GP1b, GP2, TG1b and TG2

N.I. Vavilov

N.I. Vavilov Research Institute of Plant Industry

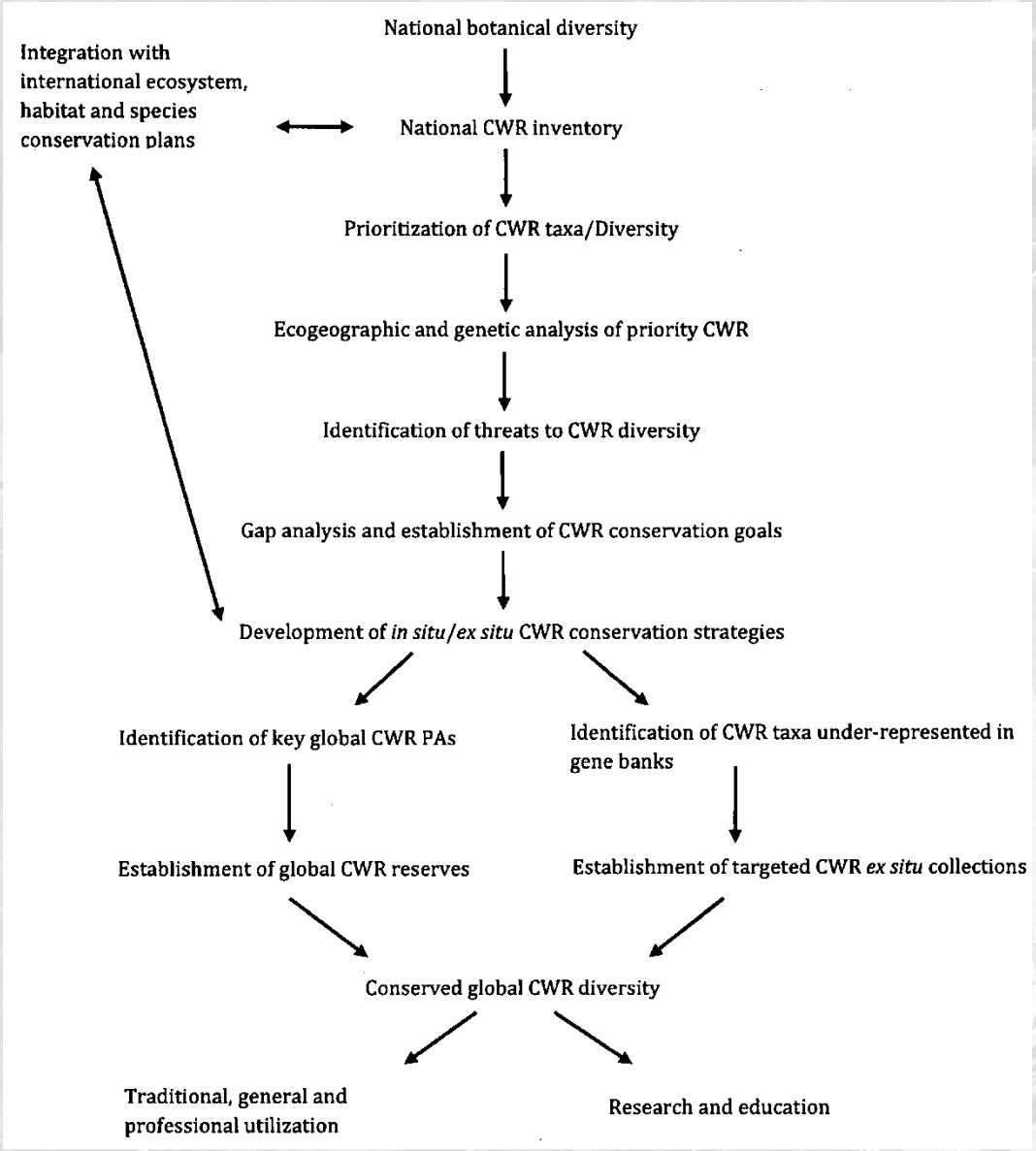
Approaches to establishing a CWR conservation strategy

- Numerous diverse approaches that result in genetically representative samples of CWR conserved
- Three basic diverse approaches:
  - Individual reserve manager
  - National / Regional
  - Global (FAO Global Strategy)
- Each concludes with CWR diversity being actively conserved in genetic reserves + safety backup held *ex situ*

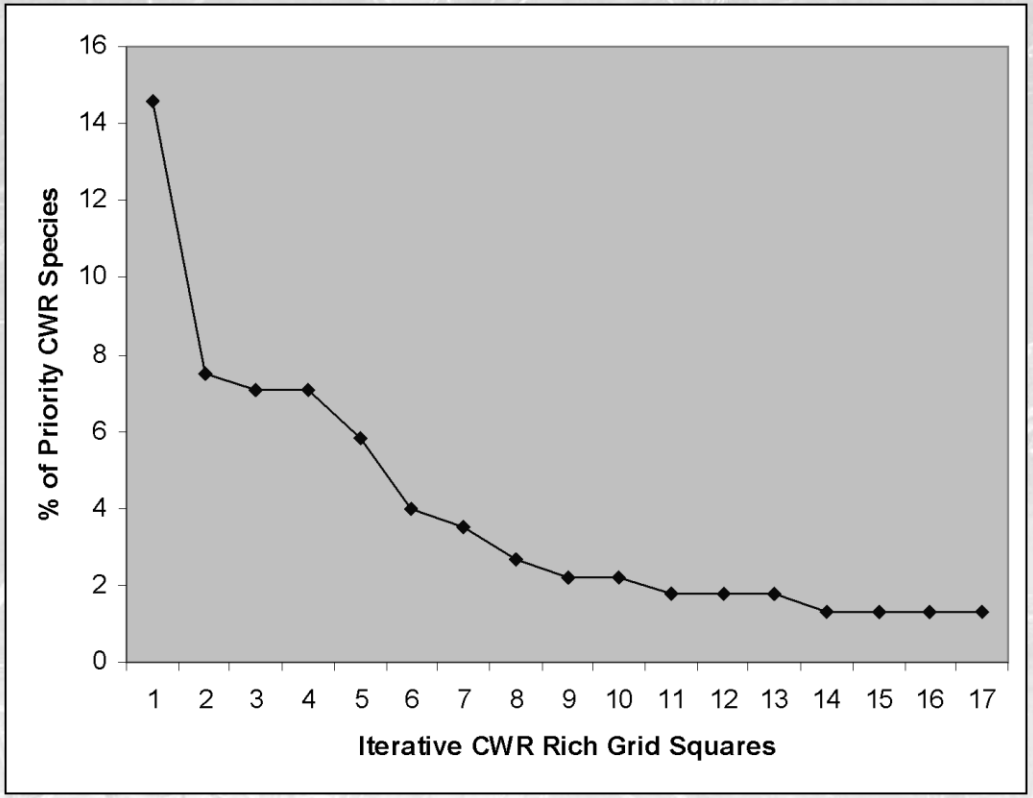
Individual CWR Genetic Reserve – Bottom-up

- CWR found widely in nature inside and outside of PA
- Each individual PA (where conservation is a focus) may not be included in national or global CWR networks
- Individual PA manager's involvement in CWR conservation
- Adapt the PA management plan to facilitate Genetic conservation of CWR diversity
- Publicize the presence of CWR species in the protected area
  - General public see PA role in helping ensure national wealth creation and food security, e.g. banana, coffee, rice in botanic gardens

National CWR Strategy



Important CWR Areas for the UK



17 10x10 km grid squares with 152 (67.3%) UK CWR species (69 sites for 100%) all have PAs

Maxted et al. (2007)

(Data source: Botanical Society of the British Isles via NBN Gateway)

Establishing the first CWR genetic reserve in the UK

The Lizard NNR in Cornwall SW England: survey of CWRs Spring 2010

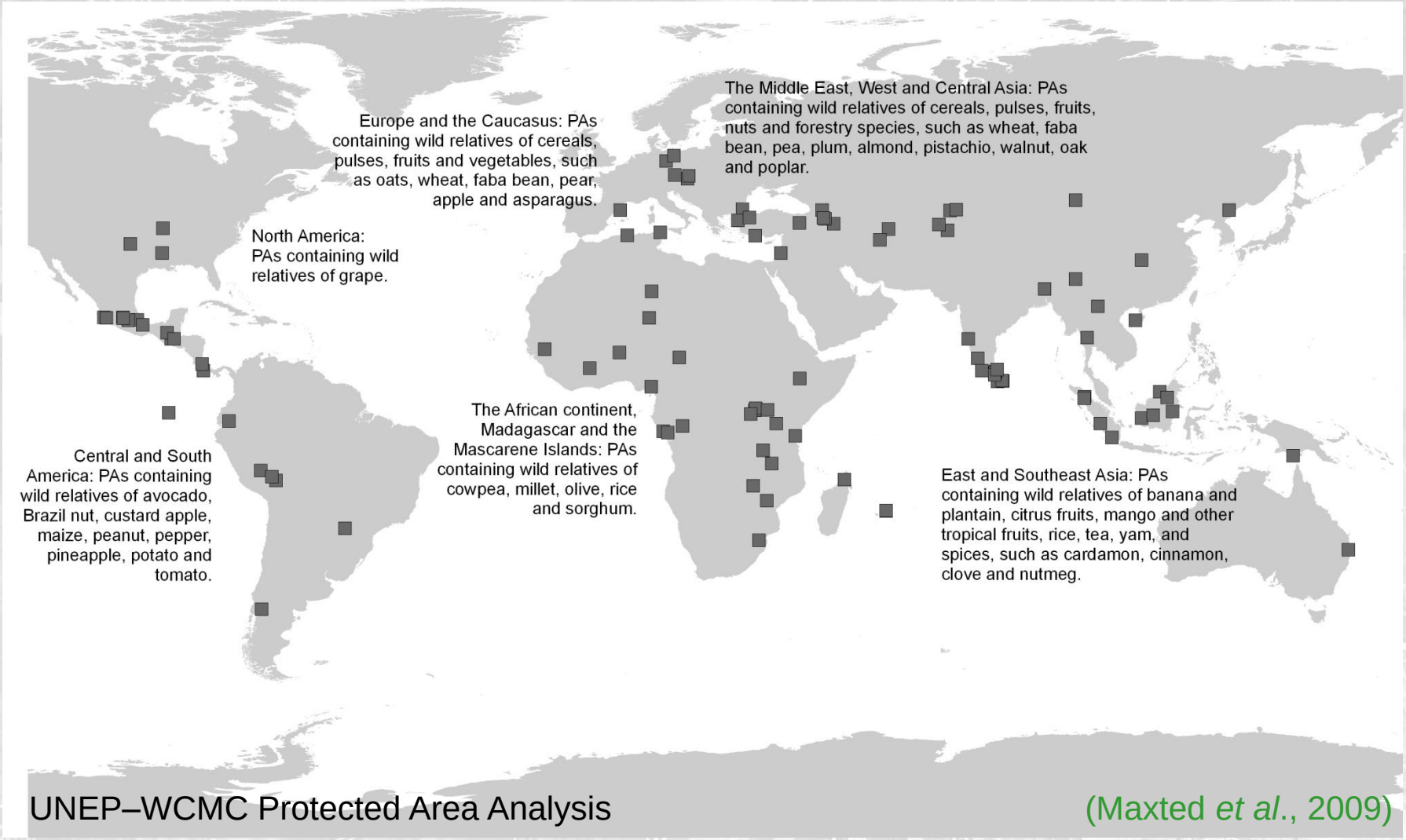
- *Allium ampeloprasum* var. *babingtonii*
- *Allium schoenoprasum*
- *Asparagus officinalis* subsp. *prostratus*
- *Beta vulgaris* subsp. *maritima*
- *Daucus carota* subsp. *gummifer*
- *Linum bienne*
- *Trifolium occidentale*
- *Trifolium repens*

FP7 PGR Secure National CWR Strategies for each European country, particularly Finland, Italy and Spain

Global CWR conservation strategy:

top down

focus on existing protected areas

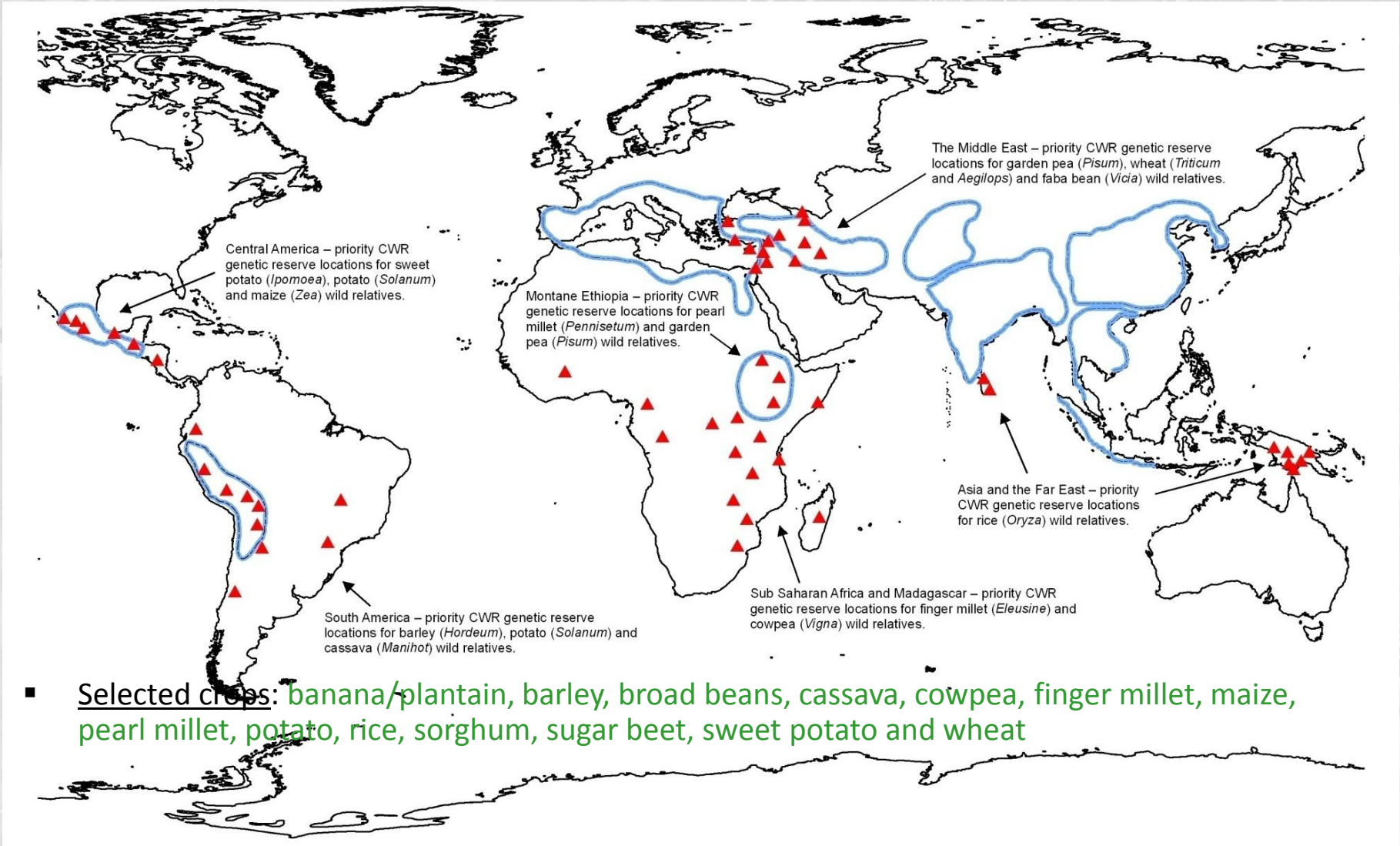


UNEP–WCMC Protected Area Analysis

(Maxted *et al*., 2009)

Global CWR conservation strategy: top down

focus on 91 major and minor crops and ±1,200 priority CWRs



- Selected crops: banana/plantain, barley, broad beans, cassava, cowpea, finger millet, maize, pearl millet, potato, rice, sorghum, sugar beet, sweet potato and wheat

FAO – *Global Network of CWR Genetic Reserves* (Maxted and Kell, 2009)

Global Crop Diversity Trust: Global *ex situ* CWR conservation

- Entirely *ex situ* focus
- 26 + 66 gene pools
- Includes: *All major and minor crop gene pools (Annex 1 + Groombridge and Jenkins 2003)*
- Primarily use orientated
- 50m$; 8m$ for collecting in first 3 years of 10 year project

What is ‘gap analysis’?

- ‘Gap analysis’ was initially associated with Margules *et al.* as a conservation evaluation technique
- Identifies areas with selected elements of biodiversity then compare with protected areas to identify under-represented areas or “gaps”
- Largely applied to indigenous forests, particularly on small islands rich in endemic species

Genetic Gap Analysis Methodology

Step 1:Circumscription of target taxon and target area

Step 2: Natural *in situ* diversity
- 2a - Taxonomic Diversity Assessment
- 2b - Genetic Diversity Assessment
- 2c - Ecogeographic Diversity Assessment
- 2d - Threat Assessment

Step 3: Current conservation strategies
- 3a - *In situ* techniques
- 3b - *Ex situ* techniques

Step 4: Setting priorities for conservation action
- 4a - *In situ* conservation priorities
- 4b - *Ex situ* conservation priorities

Maxted *et al.* (2008)

FAO Global CWR Conservation Strategy:

Under-pinning Global Food Security

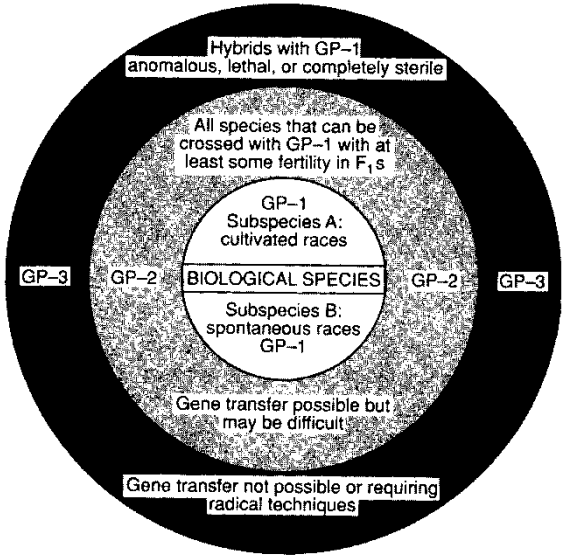
- FAO Initial analysis based on 14 crops (Banana, Barley, Cassava, Cowpea, Faba bean, Finger millet, Garden pea, Maize, Pearl millet, Potato, Rice, Sorghum, Sweet potato and Wheat)
- Global Crop Diversity Trust Gap Analysis Project on 13 gene pool (Jarvis *et al.*)
- Strong correlation with Vavilov Centres, but with obvious gaps (e.g. China, Australia, etc.)
- Temperate legume genera - *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* diversity

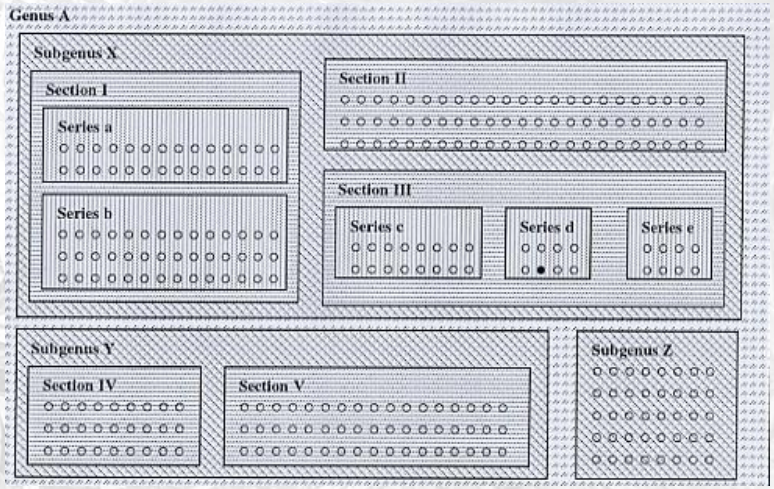
Taxonomic Diversity Assessment

Prioritised on basis of gene pool and taxon group concept

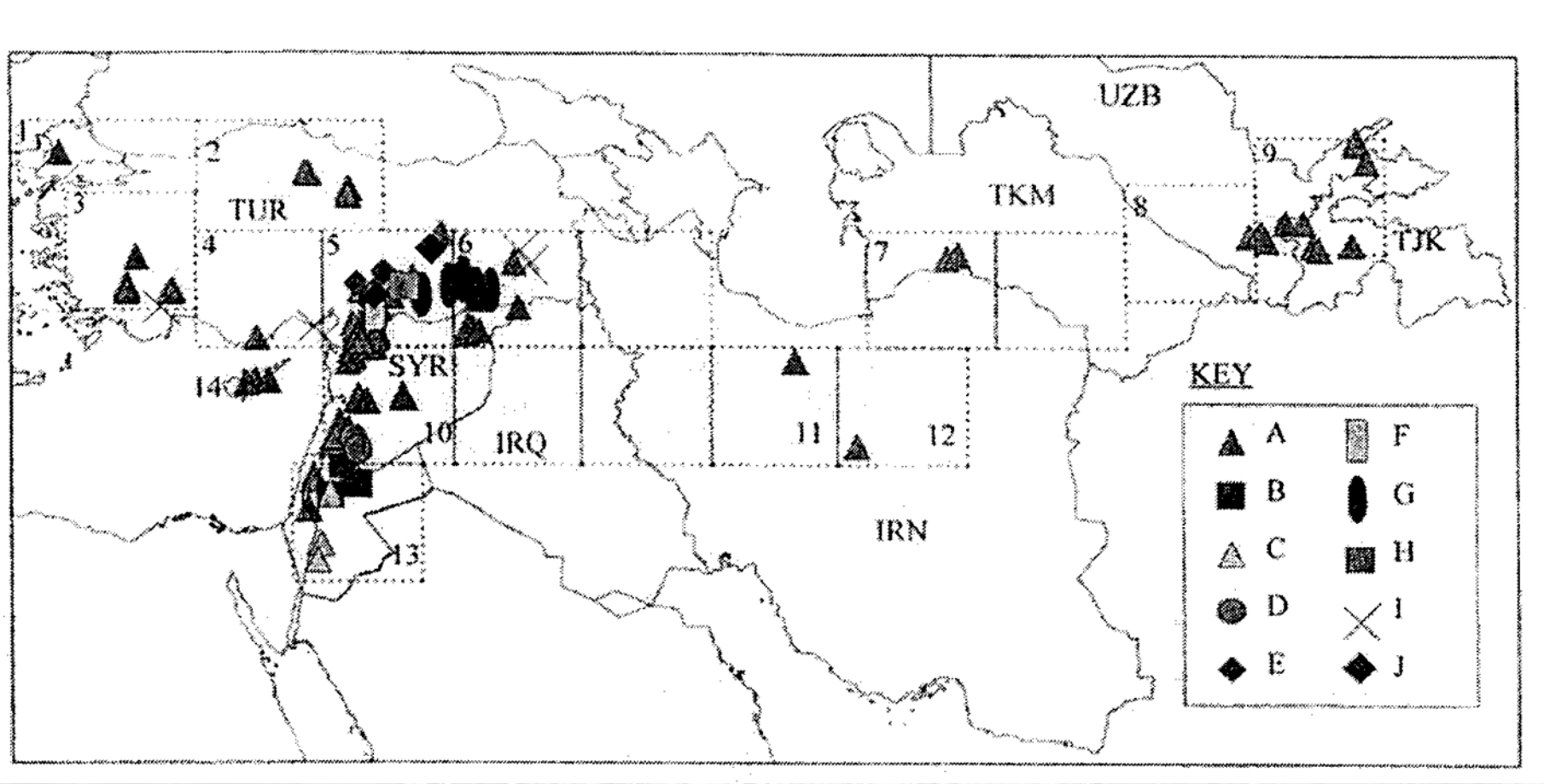
Genus	All Species	Gene Pool	Taxon Group
Cicer	44	1/6	-
Lathyrus	160	1/11	3/35
Lens	4	1/4	-
Medicago	84	1/12	1/10
Pisum	3	1/3	-
Vicia	150	2/8	5/23
Totals	445	7/44	8/68

15 Crop / 112 CWR





Genetic Diversity Assessment



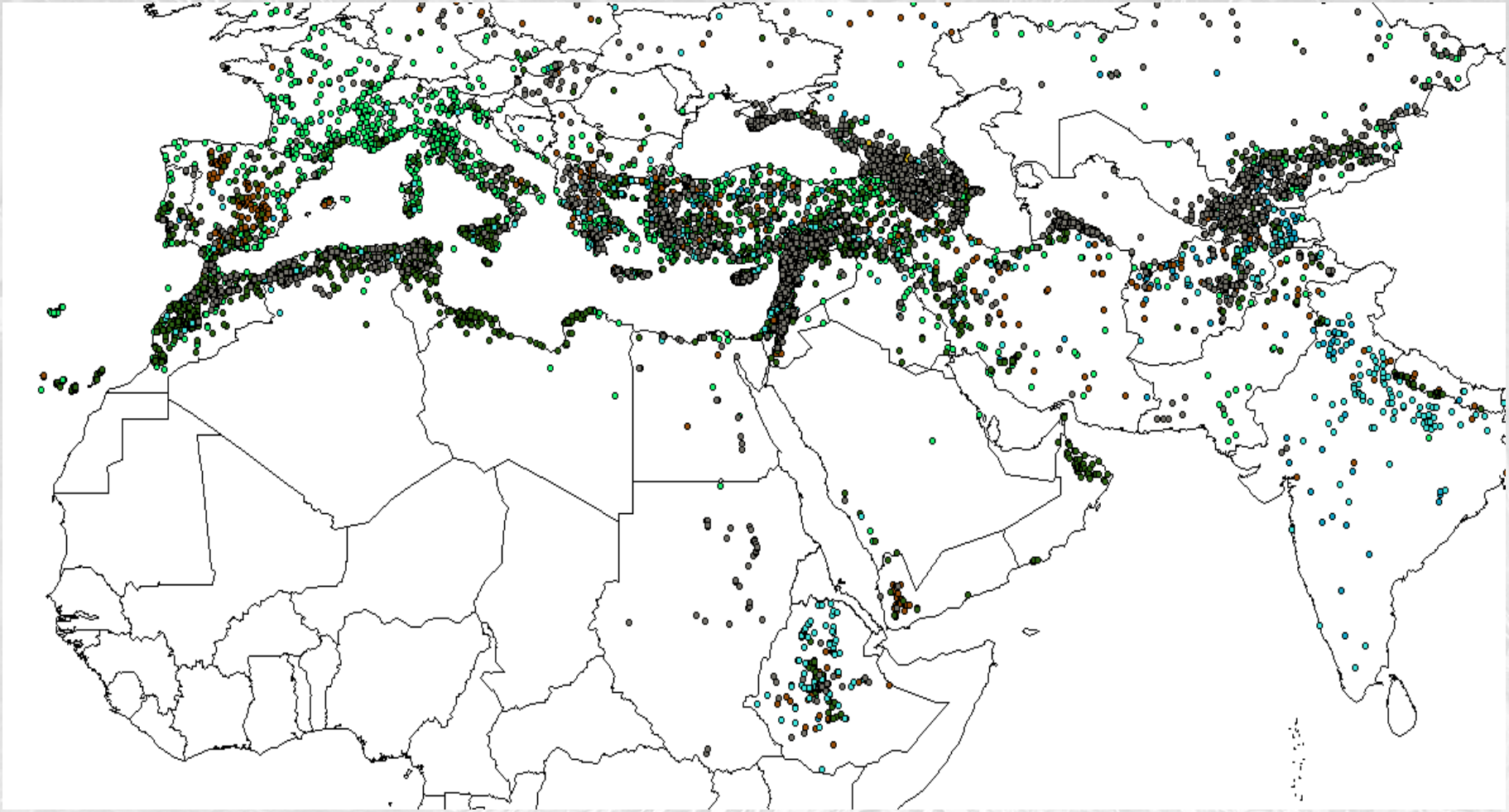
Genetic diversity of wild lentils – Ferguson *et al.* (1998)

Ecogeographic Diversity and Gap Analysis: Temperate Legumes

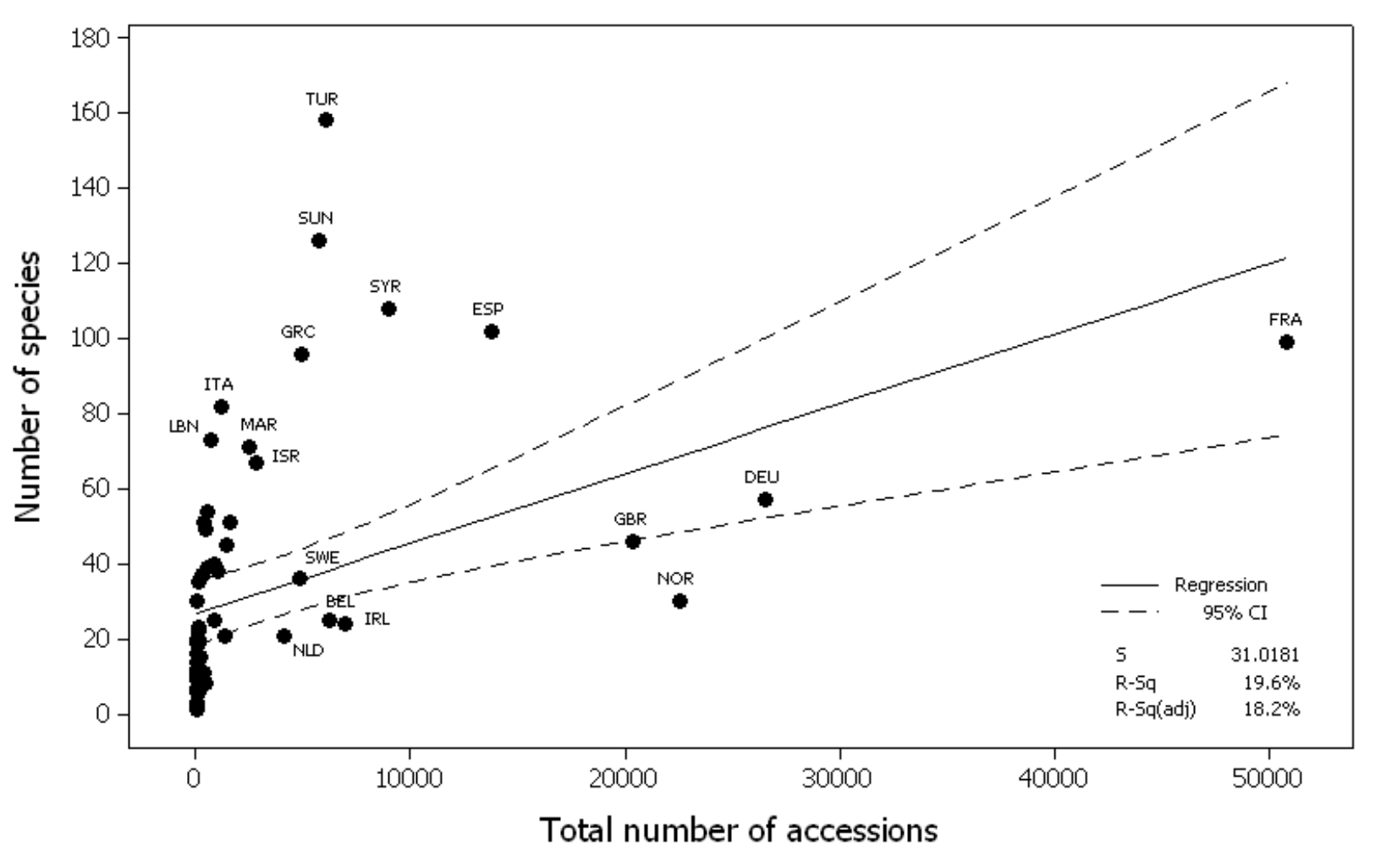
- Based on 200,281 unique geo-referenced herbarium specimens and germplasm accessions (*Cicer* - 452, *Lathyrus* - 61,081, *Lens* - 672, *Medicago* -42,248, *Pisum* - 728 and *Vicia* - 95,100
- Collected between 1884 and 2008
- Bulk of germplasm accessions data from EURISCO, GBIF, ICARDA gene bank and group collections
- Forms the basis of analysis

Analysis: Temperate Legumes

Collection Density in Southern Europe, West Asia and North Africa for all *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* species

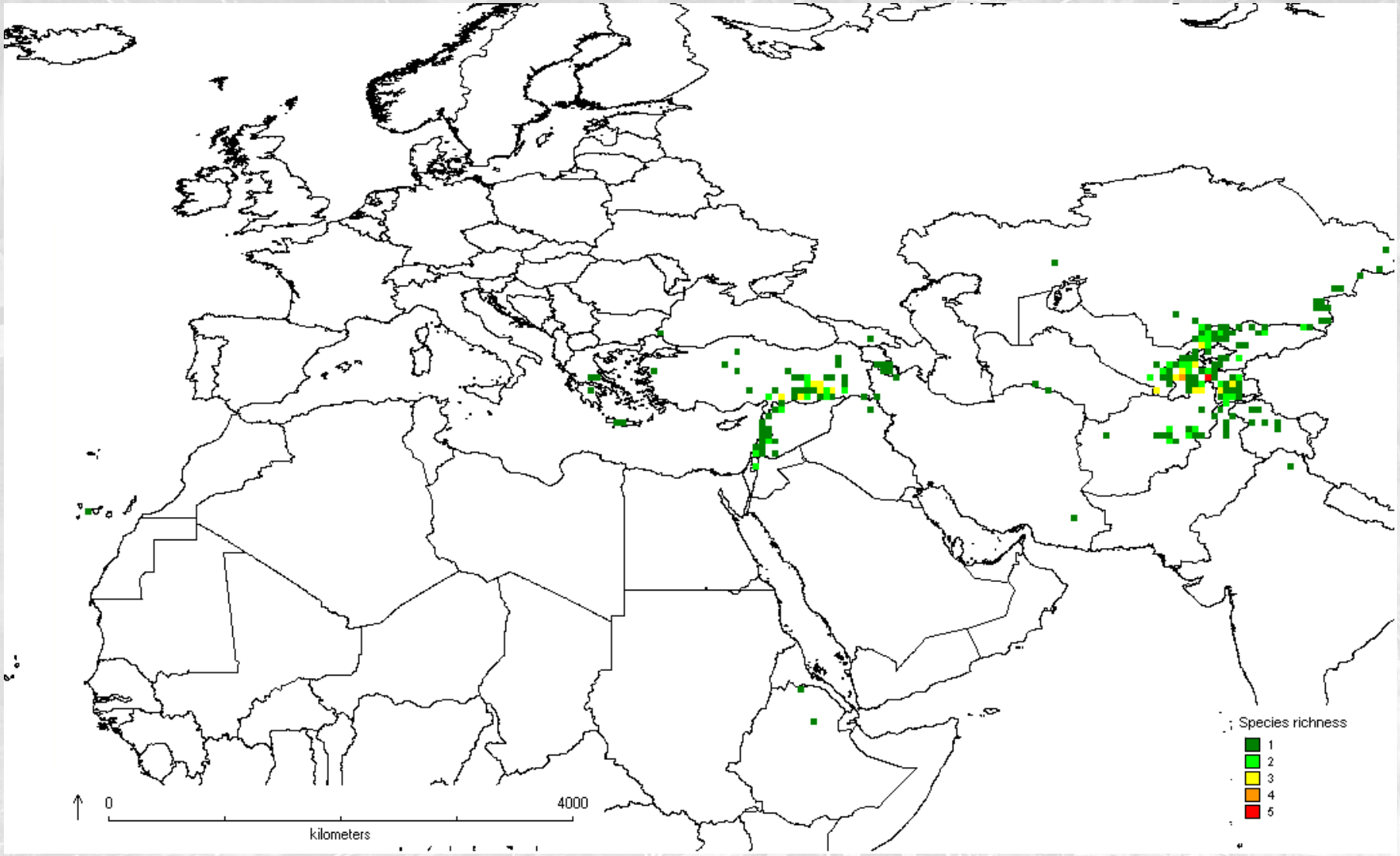


Regression of *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* species against all accessions for each country



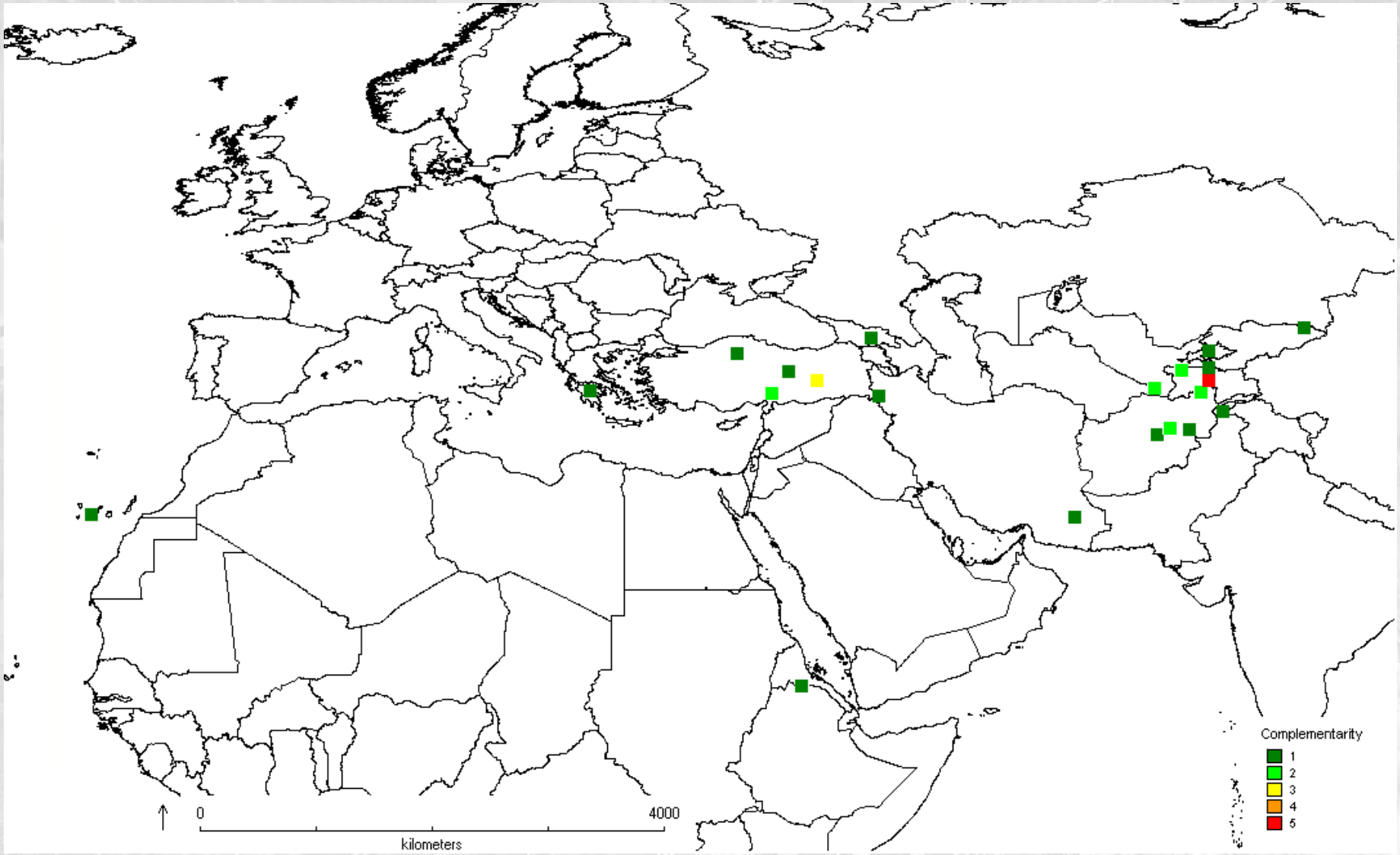
Analysis: Temperate Legumes

All 44 species Species Richness for *Cicer* species



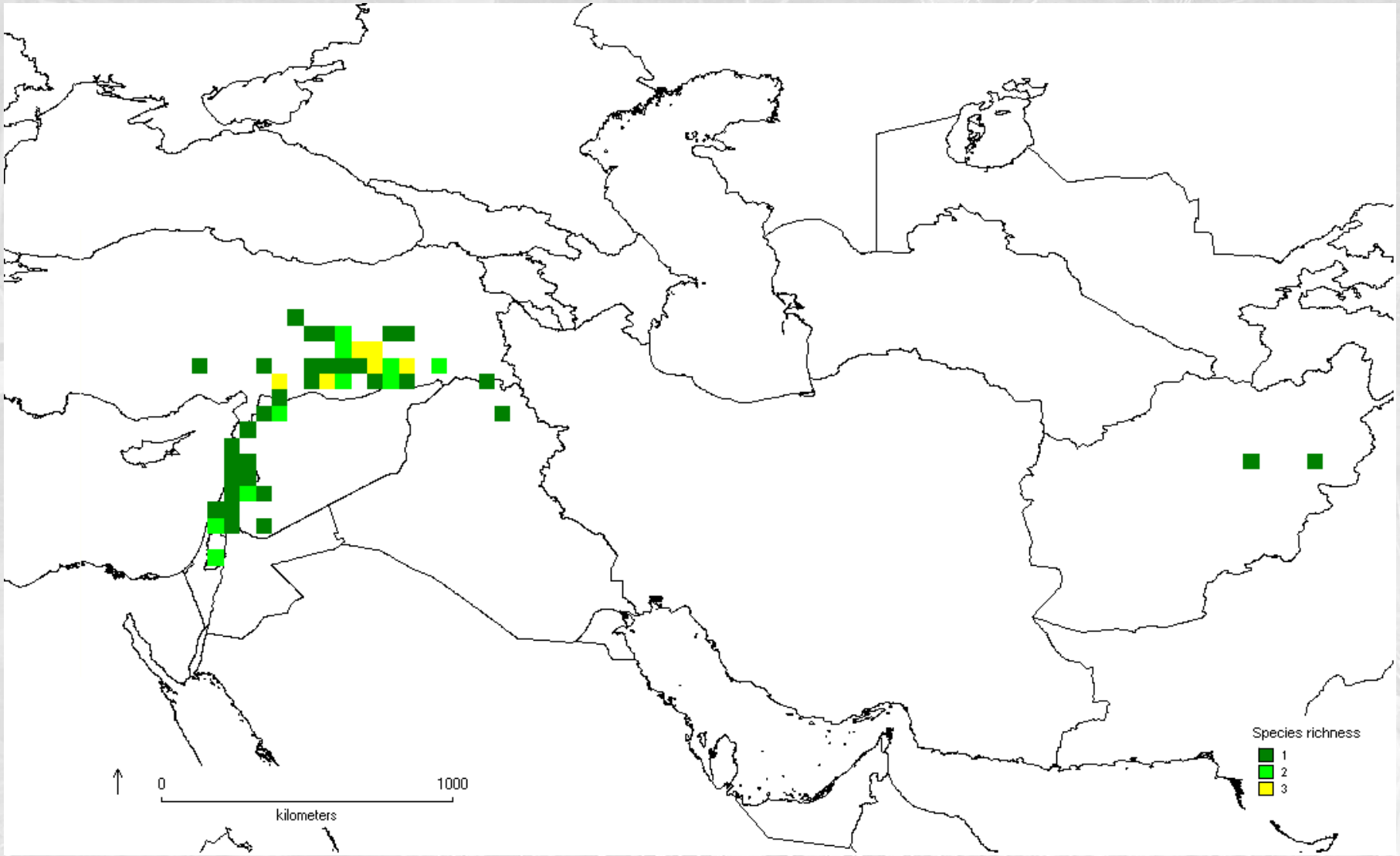
Analysis: Temperate Legumes

All 44 species Complementarity Analysis for *Cicer* species



Analysis: Temperate Legumes

6 Priority species Species Richness for *Cicer* species



Analysis: Temperate Legumes

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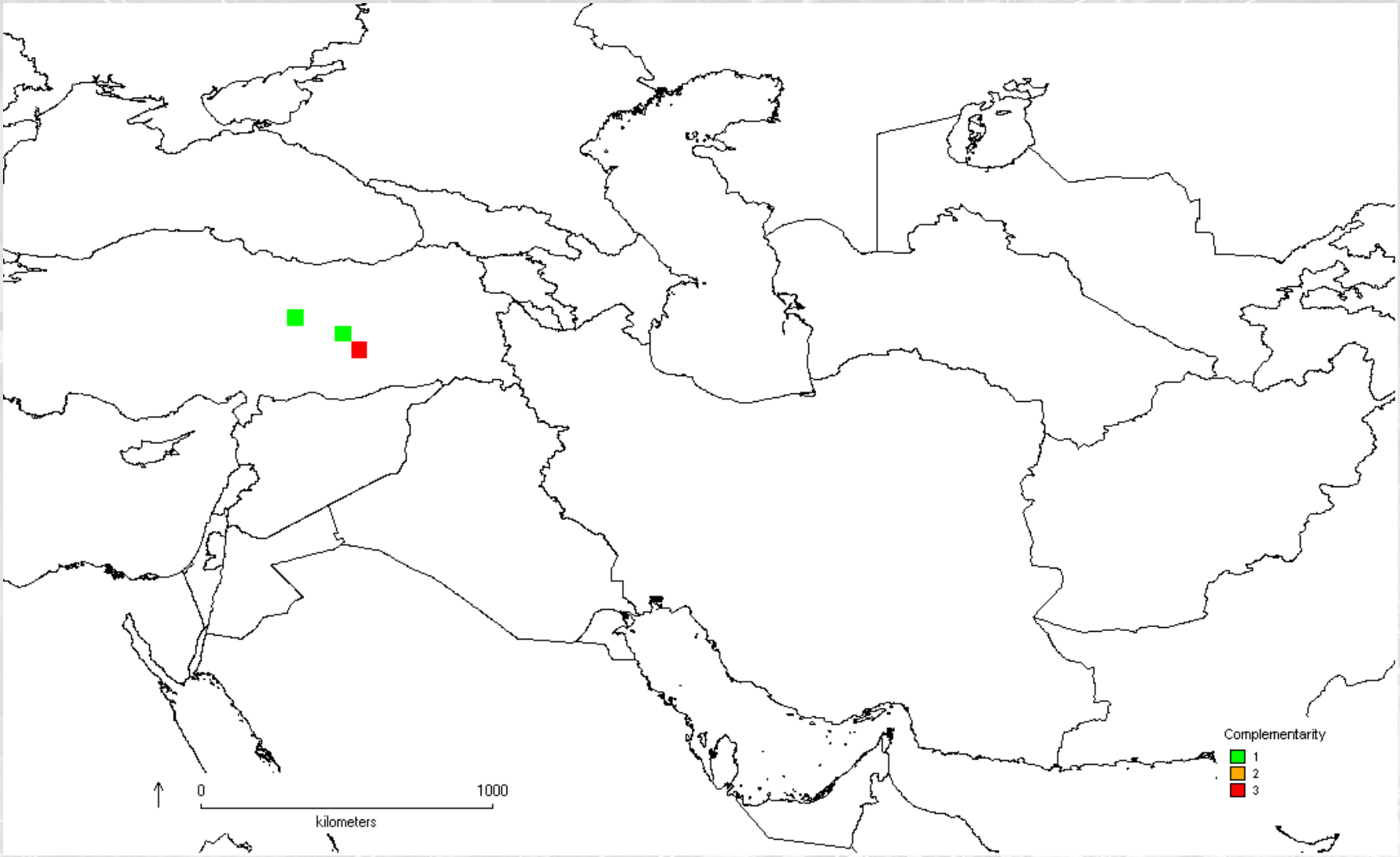
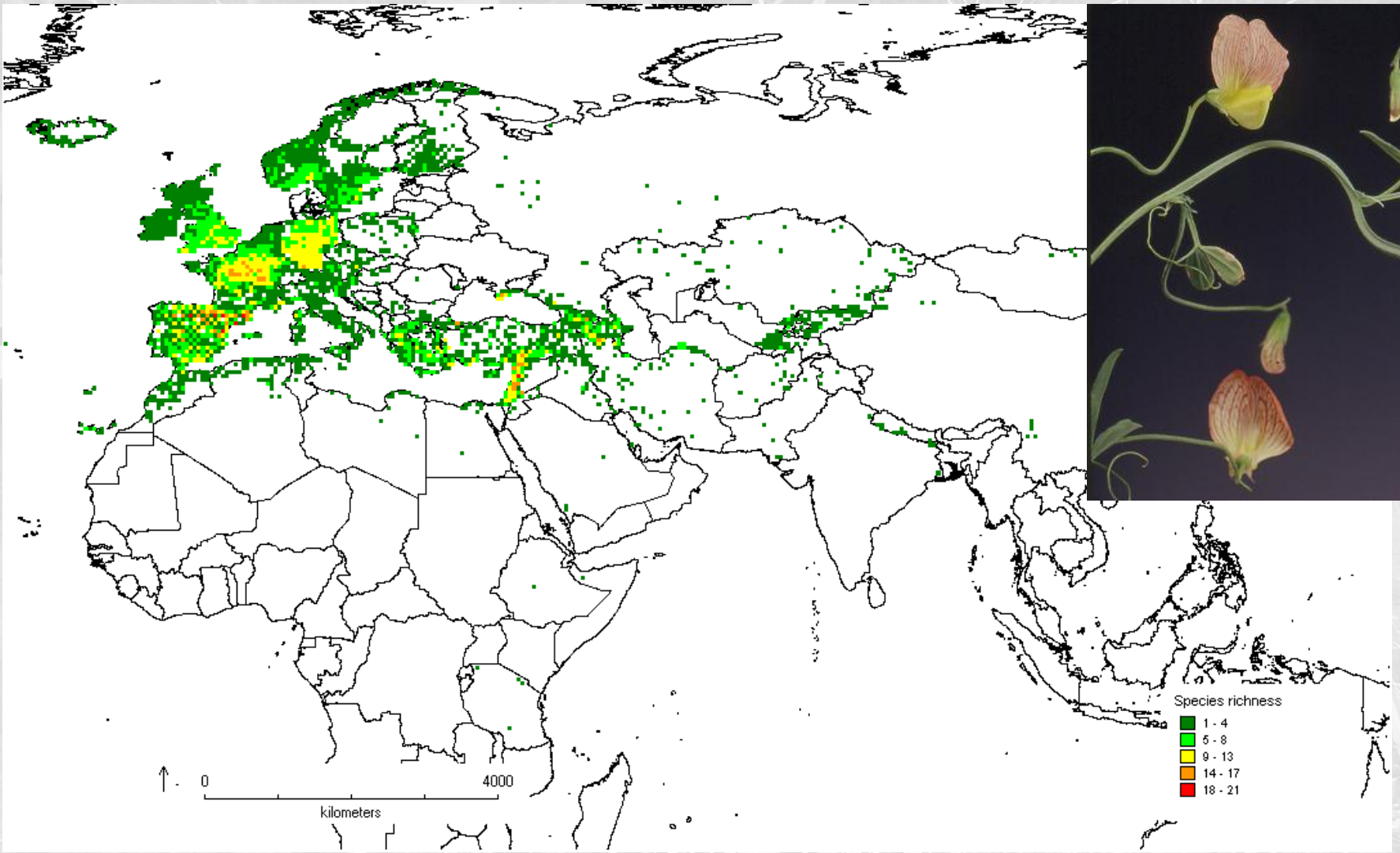


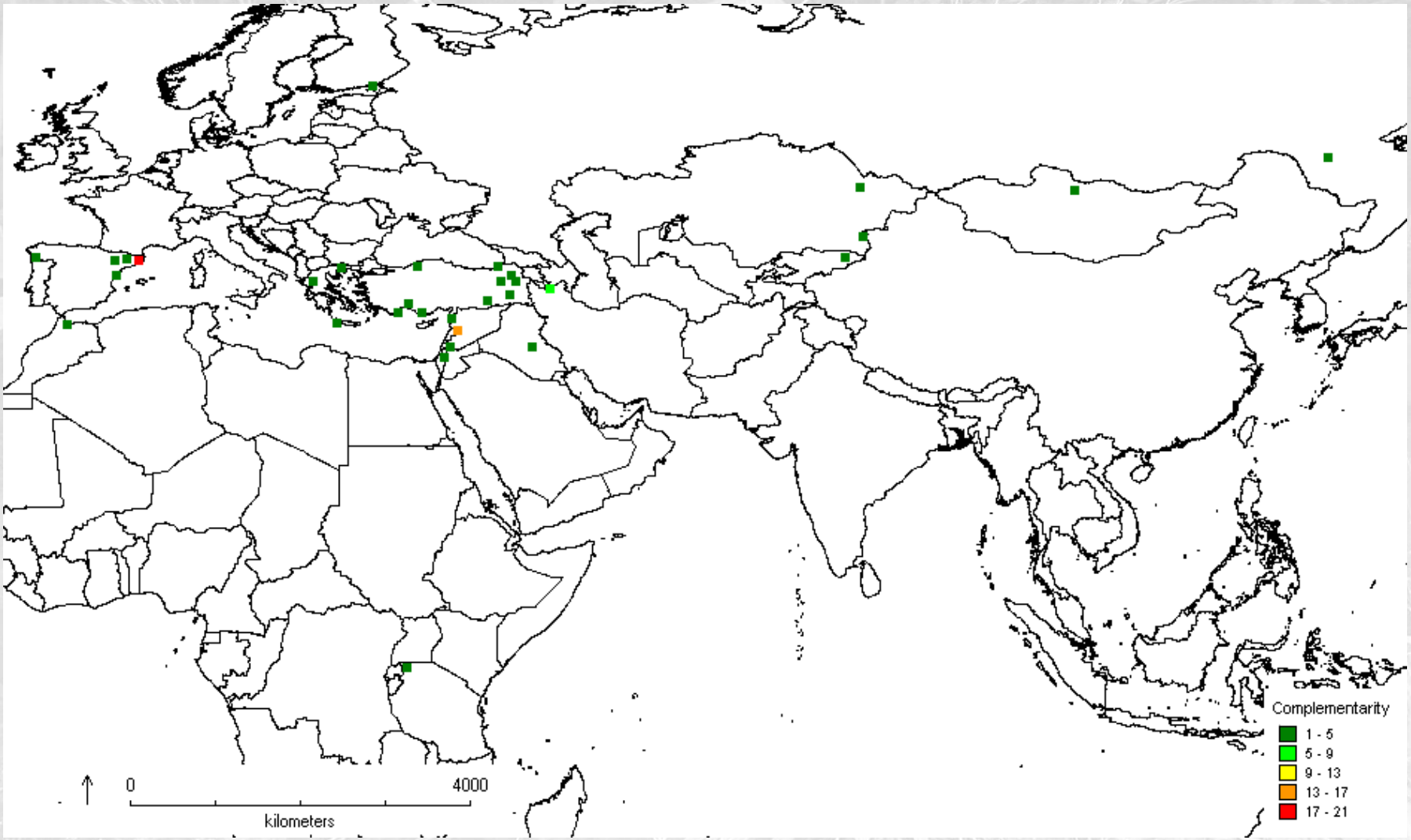
Analysis: Temperate Legumes

All 160 species Species Richness for *Lathyrus* species



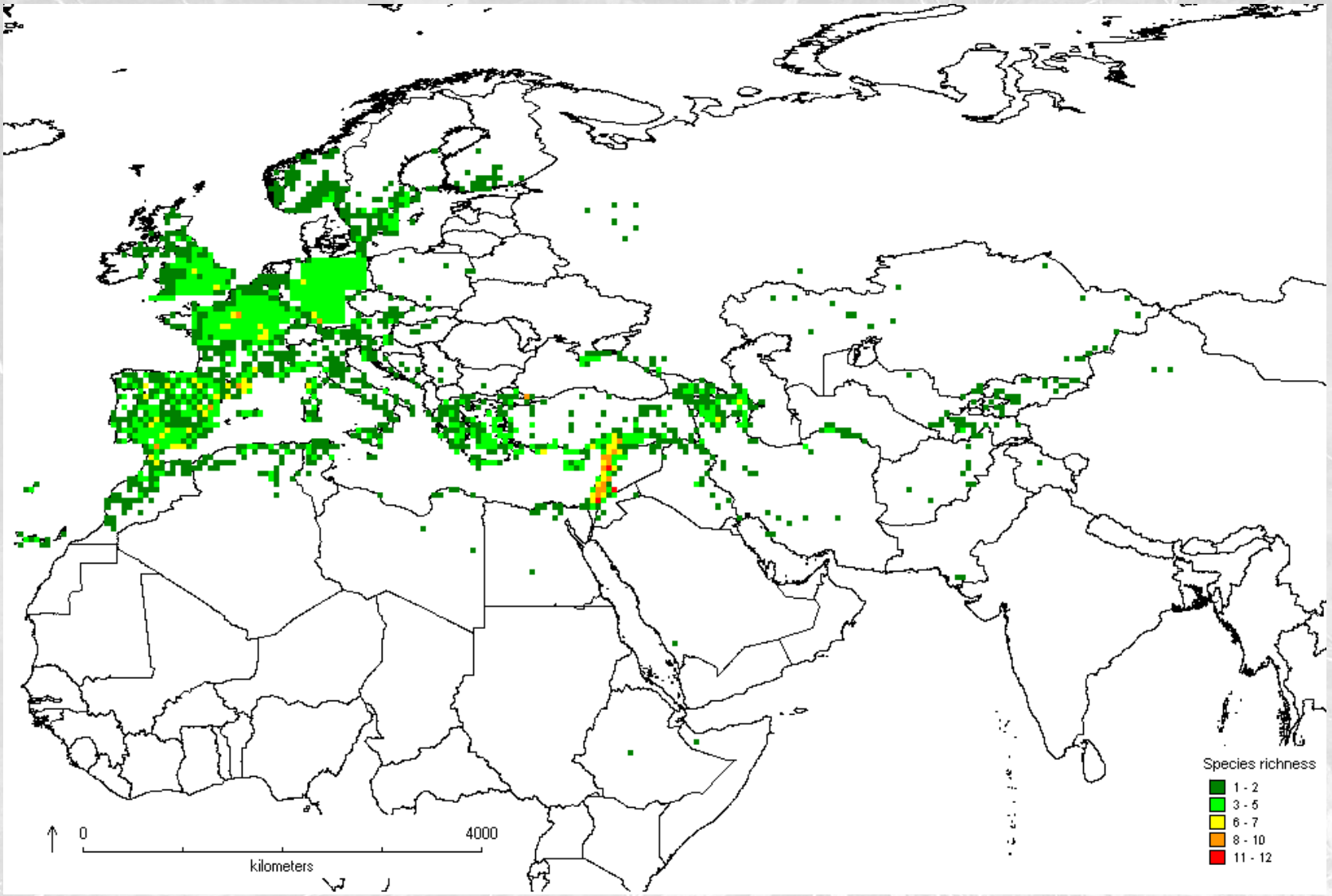
Analysis: Temperate Legumes

All 160 species Complementarity Analysis for *Lathyrus* species



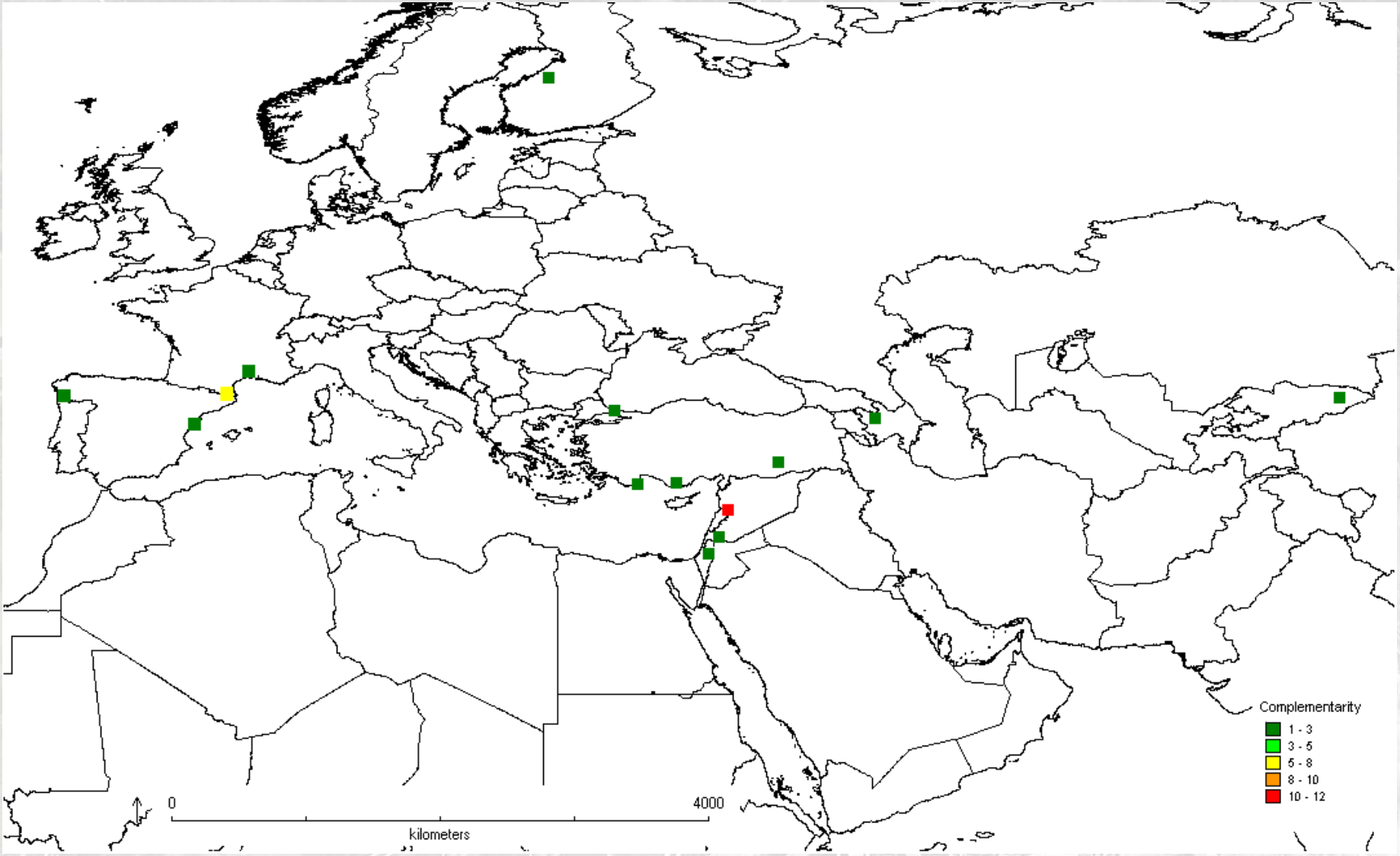
Analysis: Temperate Legumes

Priority 46 species Species Richness for *Lathyrus* species



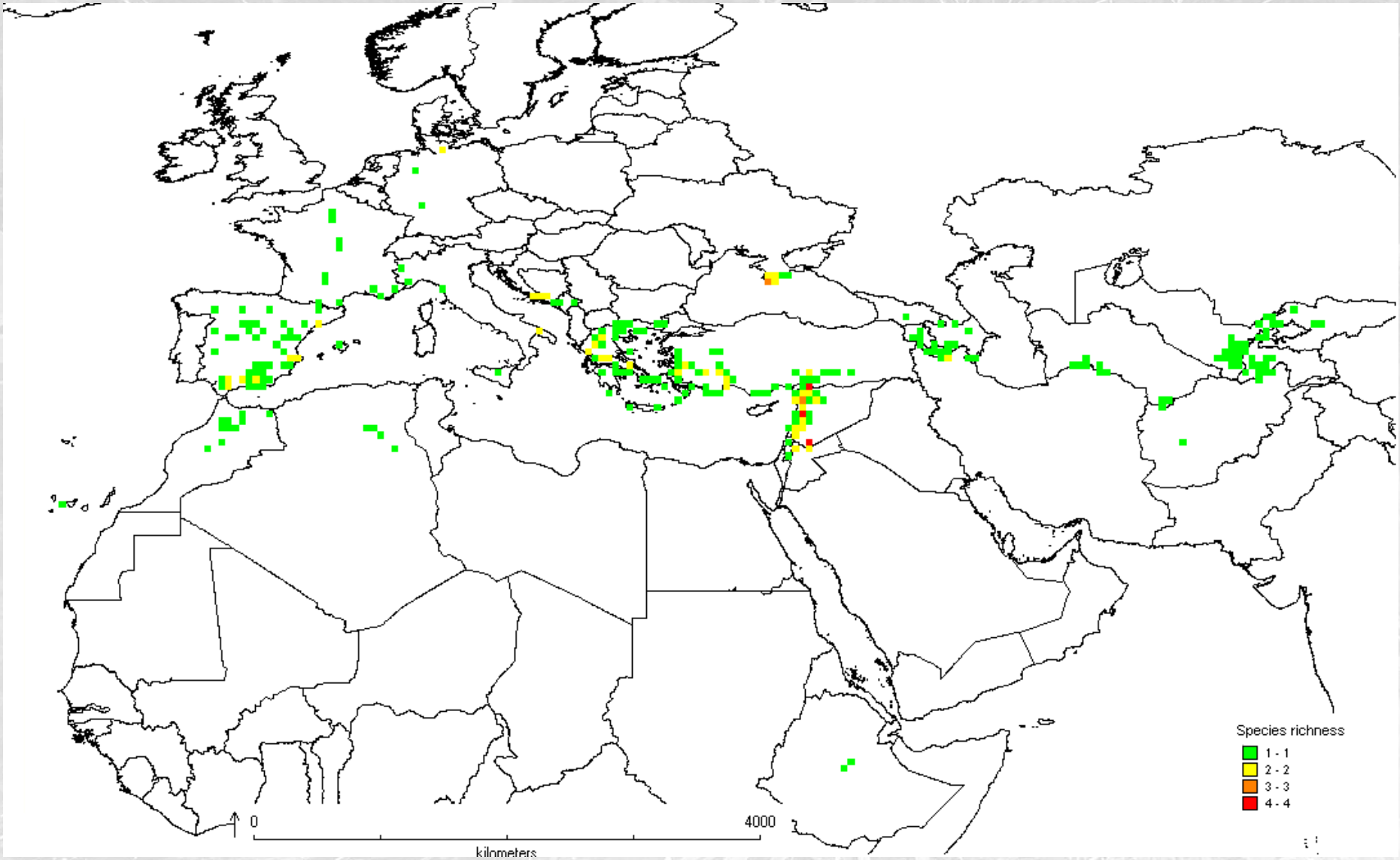
Analysis: Temperate Legumes

Priority 46 species Complementarity Analysis for *Lathyrus* species



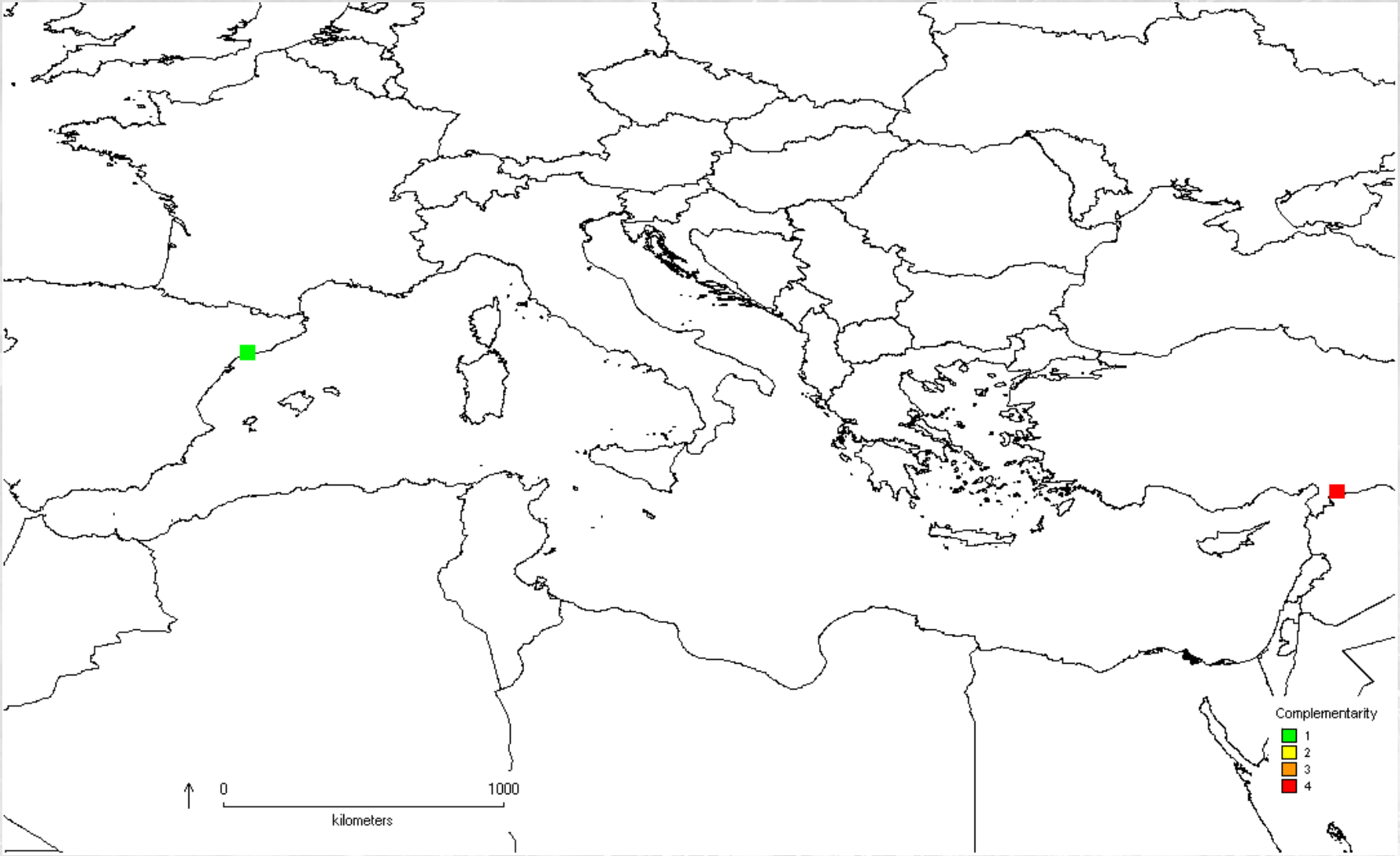
Analysis: Temperate Legumes

All / priority 4 species Species Richness for *Lens* species



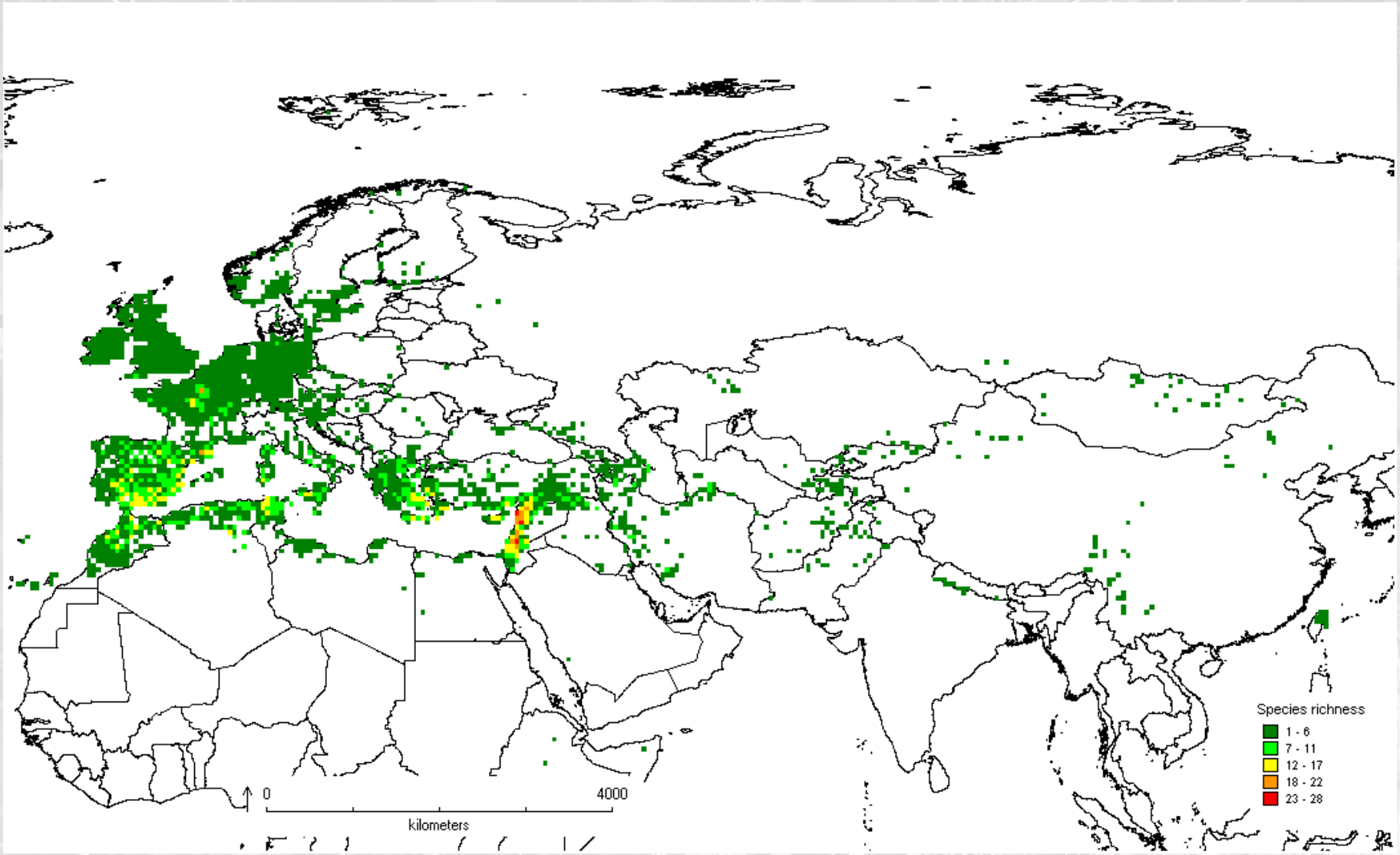
Analysis: Temperate Legumes

All / priority 4 species Complementarity Analysis for *Lens* species



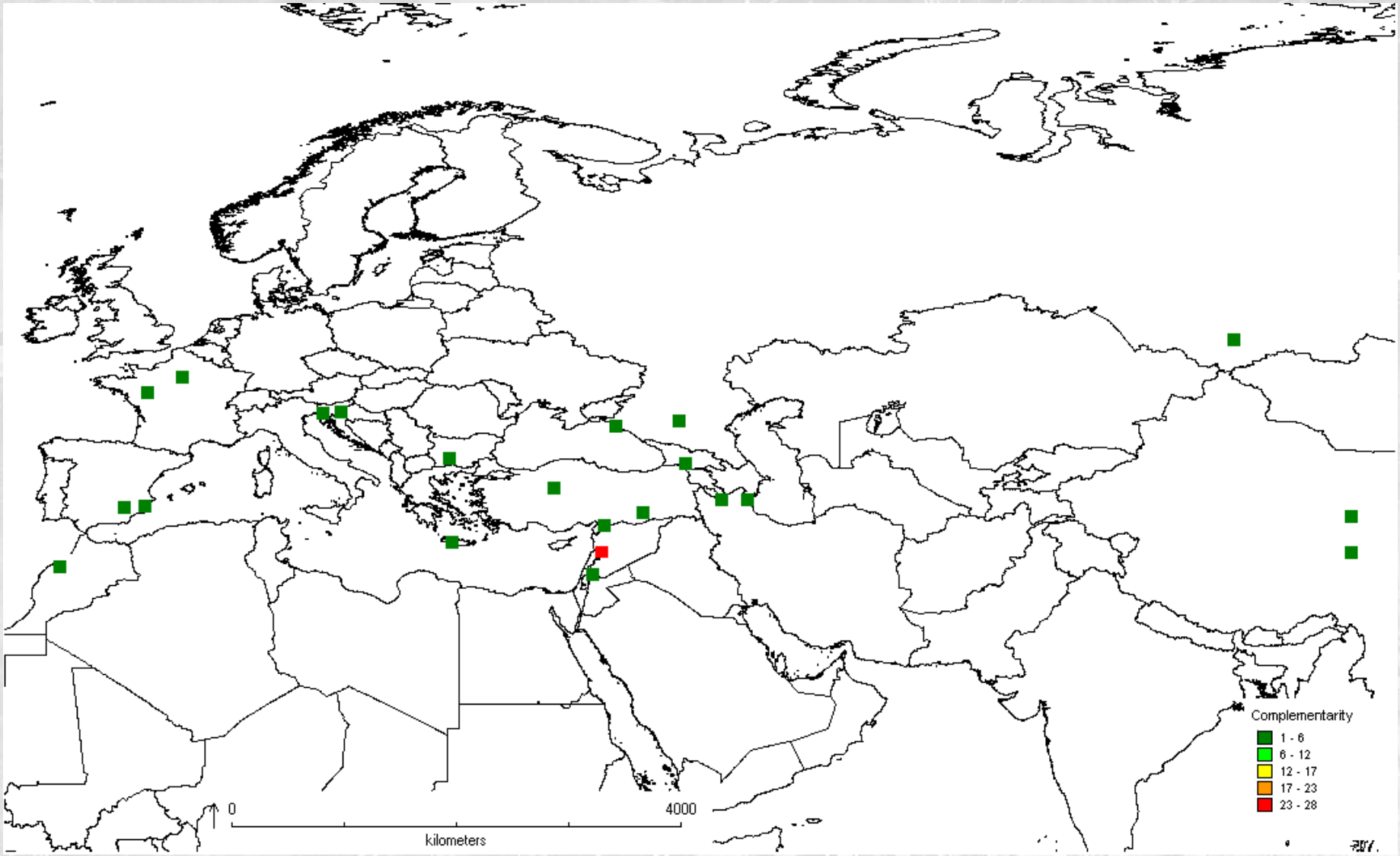
Analysis: Temperate Legumes

All species 84 Species Richness for *Medicago* species



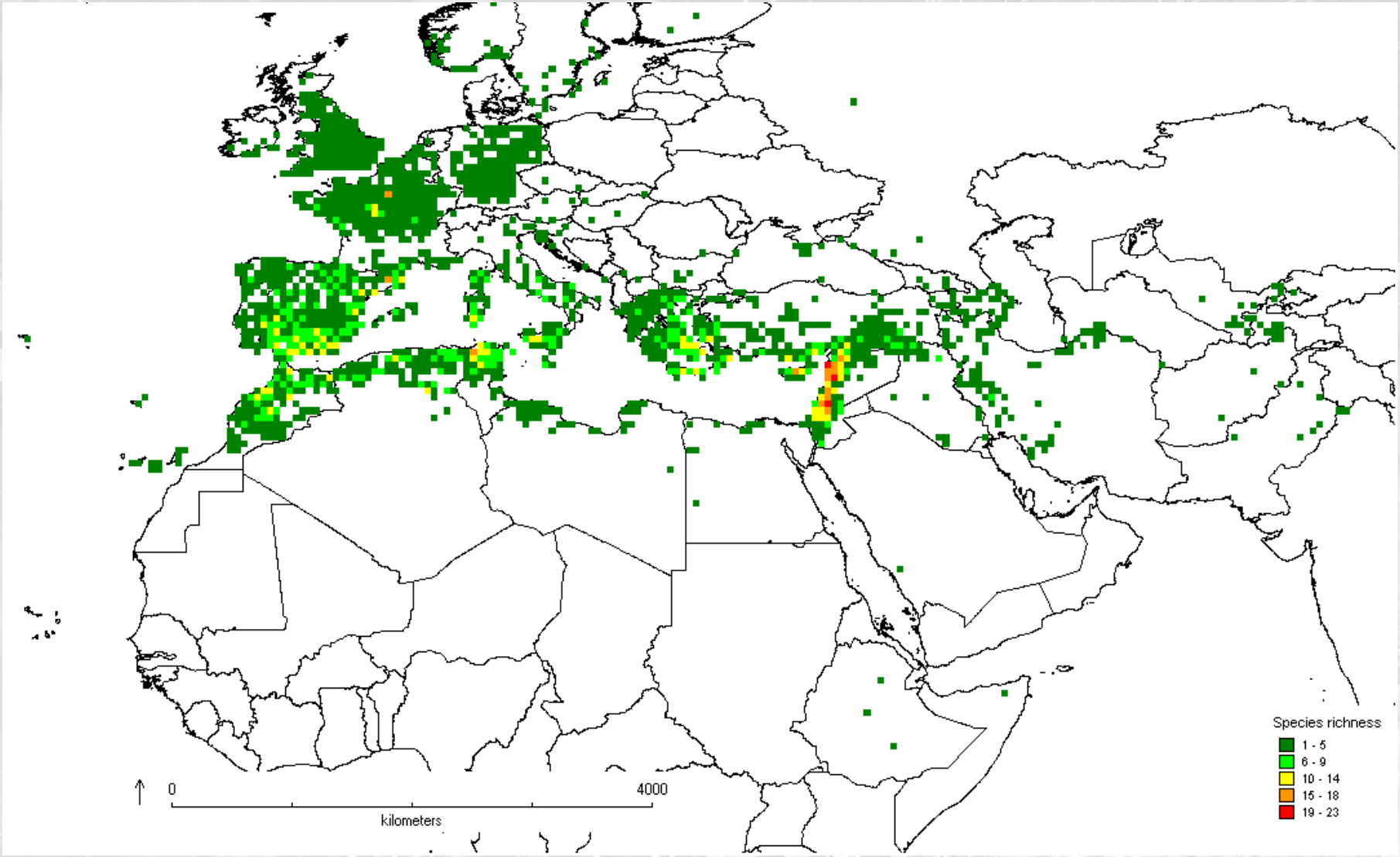
Analysis: Temperate Legumes

All species 84 Complementarity Analysis for *Medicago* species



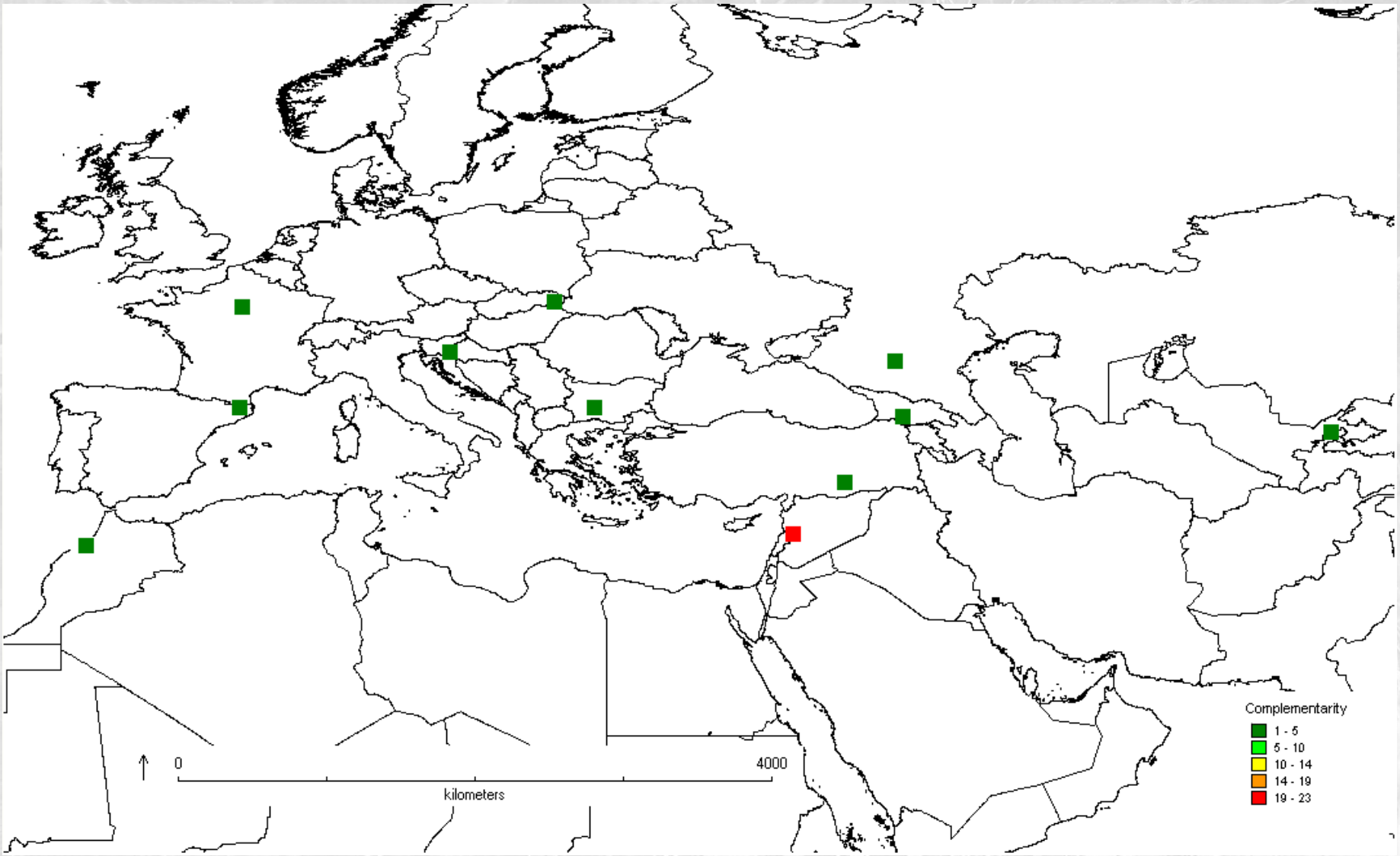
Analysis: Temperate Legumes

Priority 22 species Species Richness for *Medicago* species



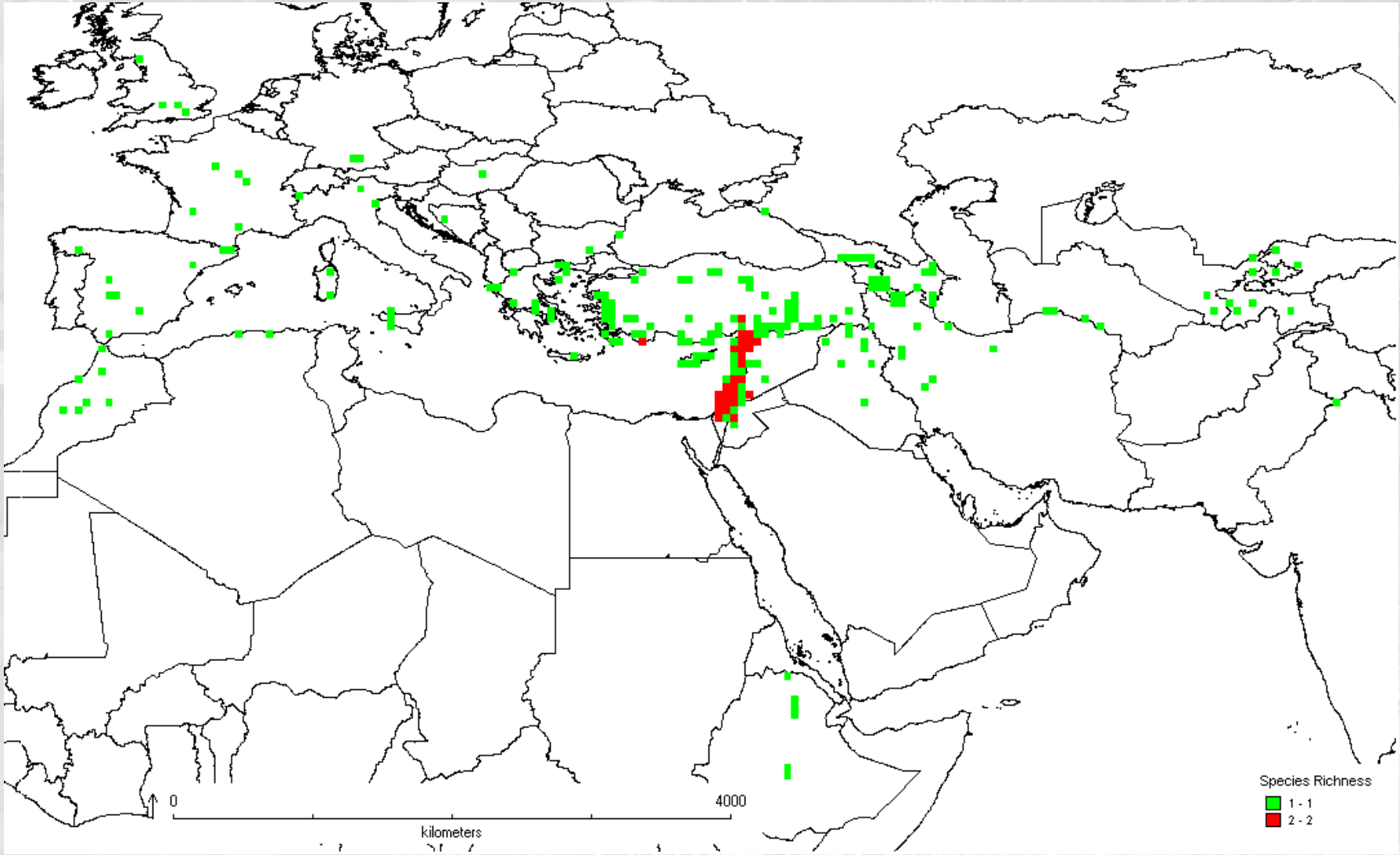
Analysis: Temperate Legumes

Priority 22 species Complementarity Analysis for *Medicago* species



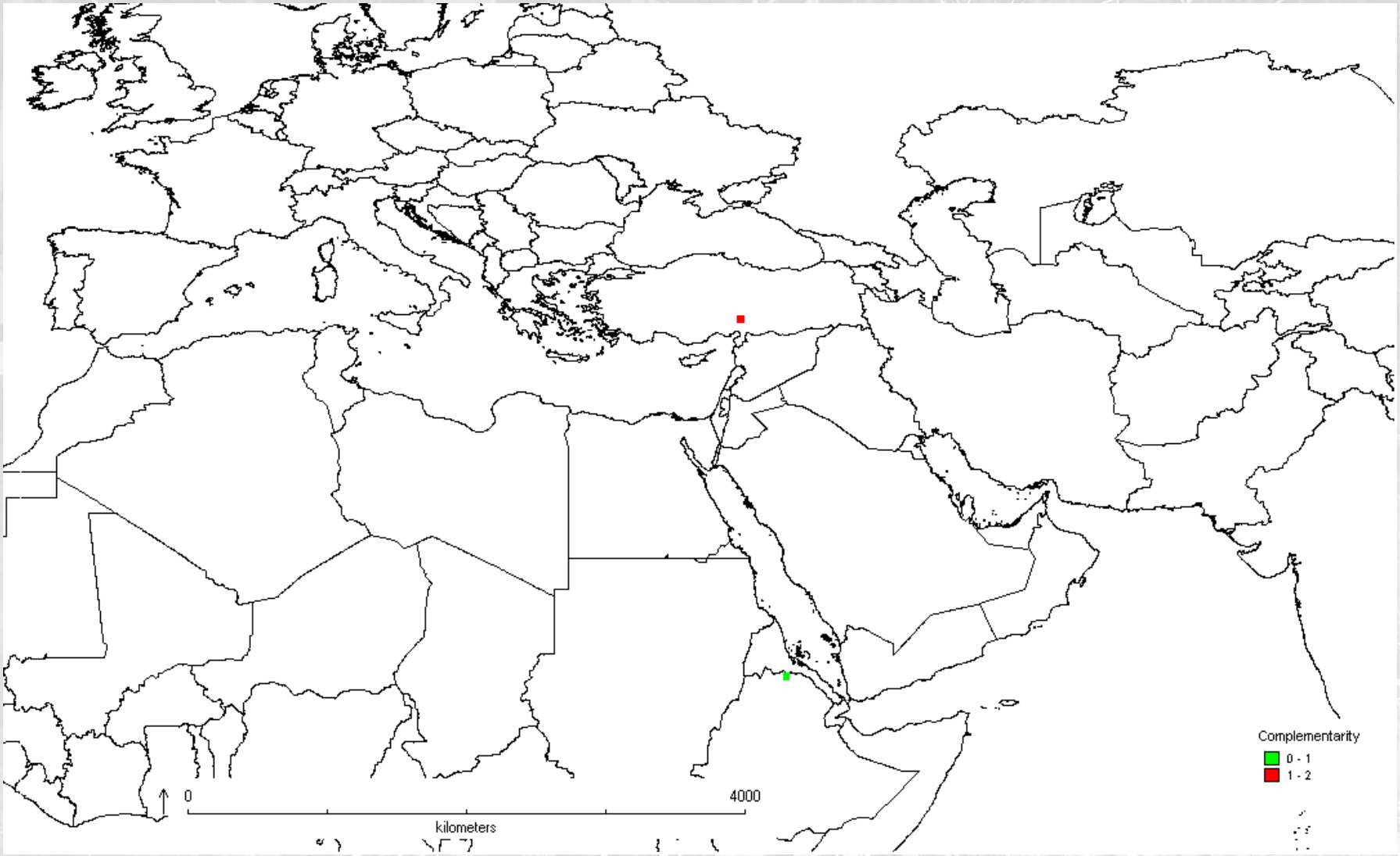
Analysis: Temperate Legumes

All / priority 3 species Species Richness for *Pisum* species



Analysis: Temperate Legumes

All / priority 3 species Complementarity Analysis for *Pisum* species

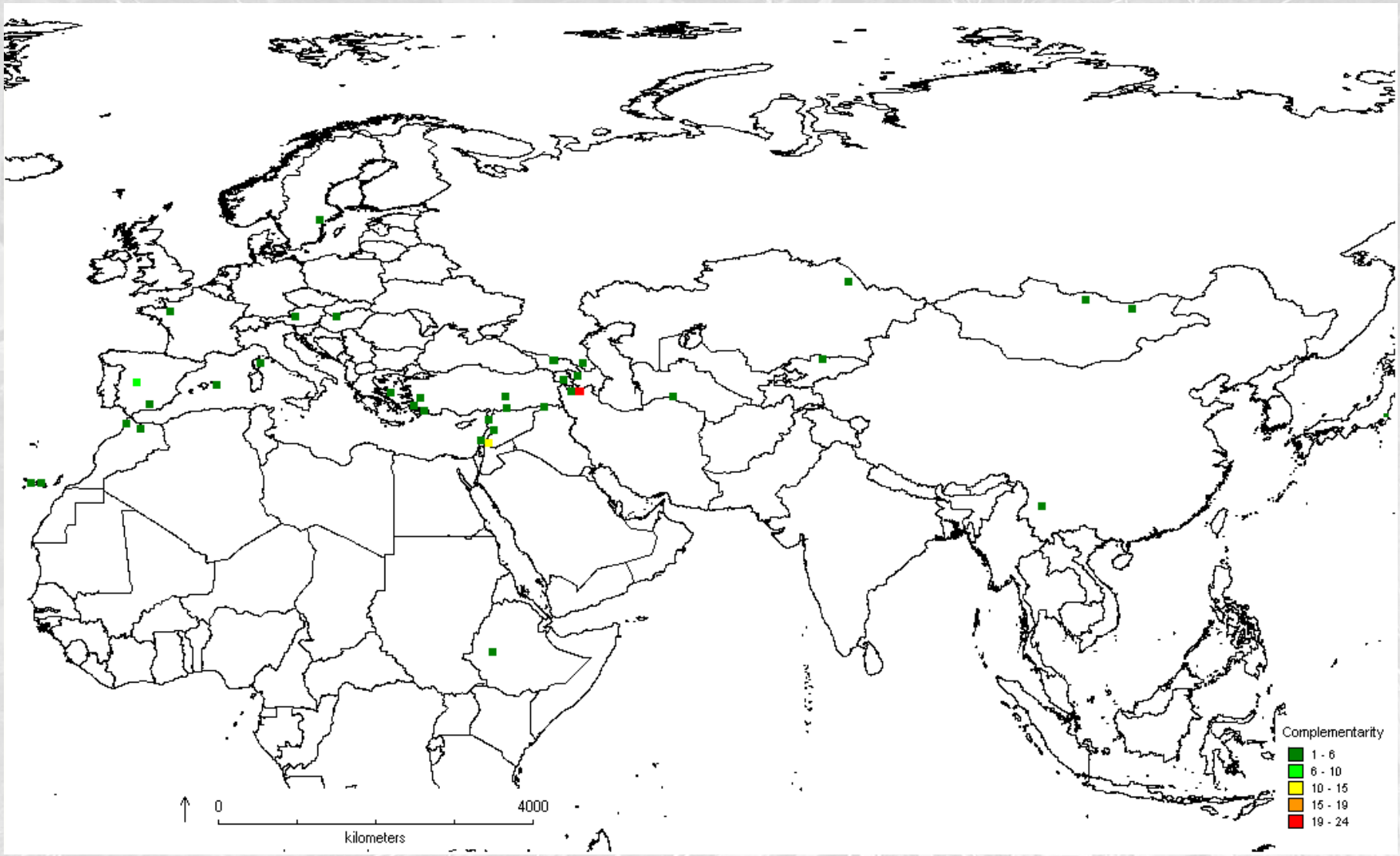


Analysis: Temperate Legumes

All 150 species Species Richness for *Vicia* species

Analysis: Temperate Legumes

All 150 species Complementarity Analysis for *Vicia* species

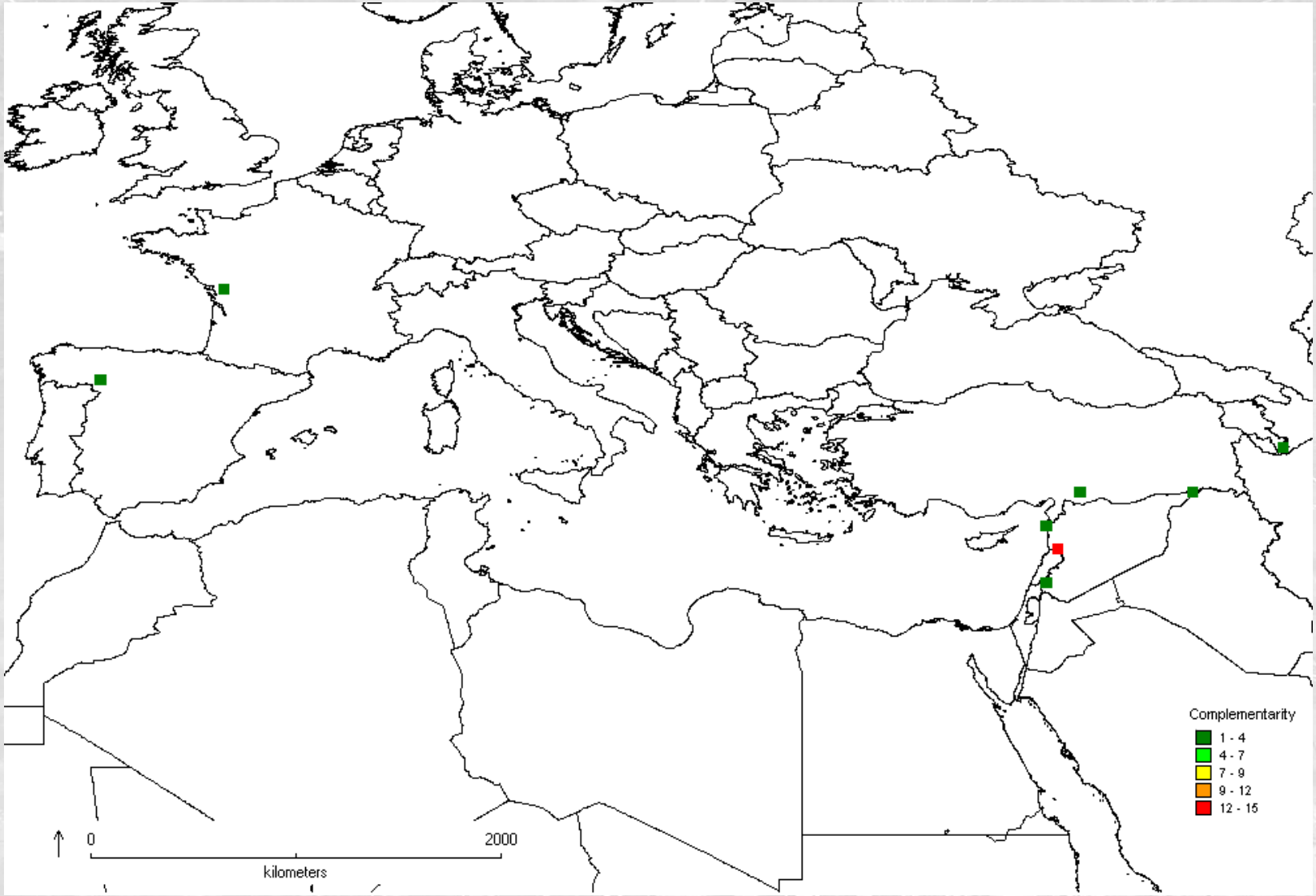


Analysis: Temperate Legumes

Priority 31 species Species Richness for *Vicia* species

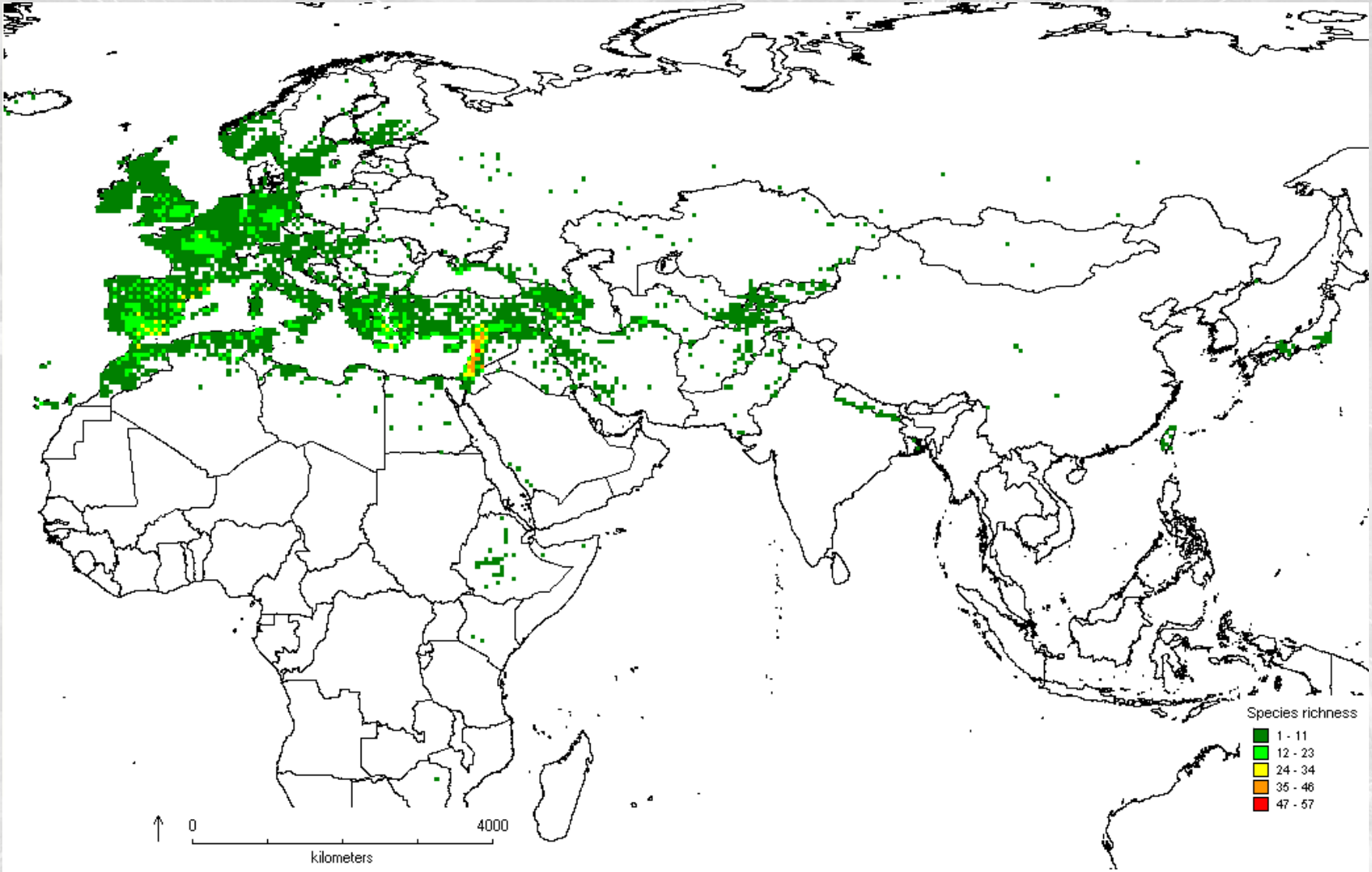
Analysis: Temperate Legumes

Priority 31 species Complementarity Analysis for *Vicia* species



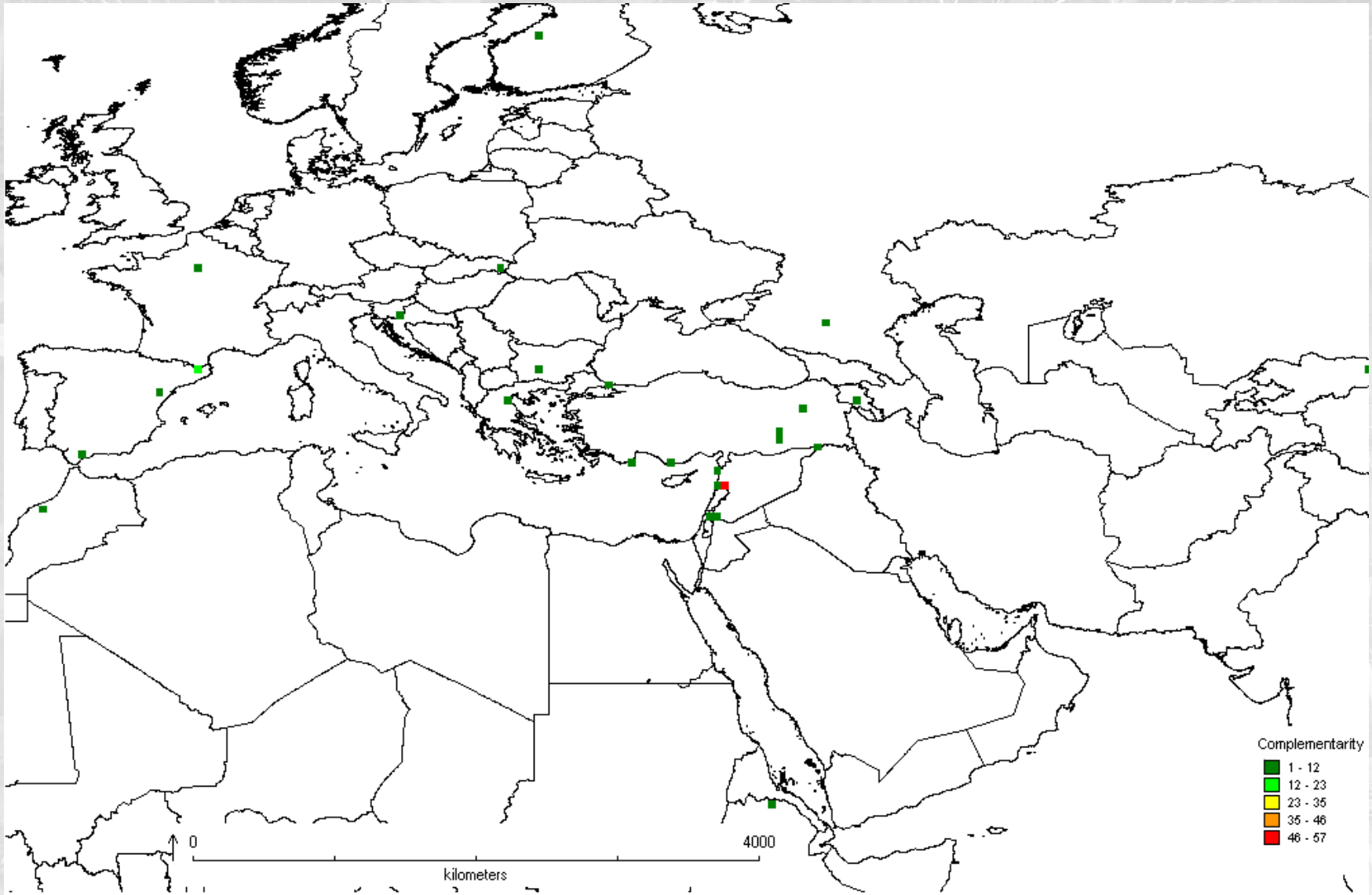
Analysis: Temperate Legumes

112 Priority species Species Richness for *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* species



Analysis: Temperate Legumes

112 Priority species Complementarity Analysis for *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* species



Analysis: Temperate Legumes

Analysis results:

1.Gap analysis is a useful tool for identifying *ex situ* and *in situ* conservation priorities

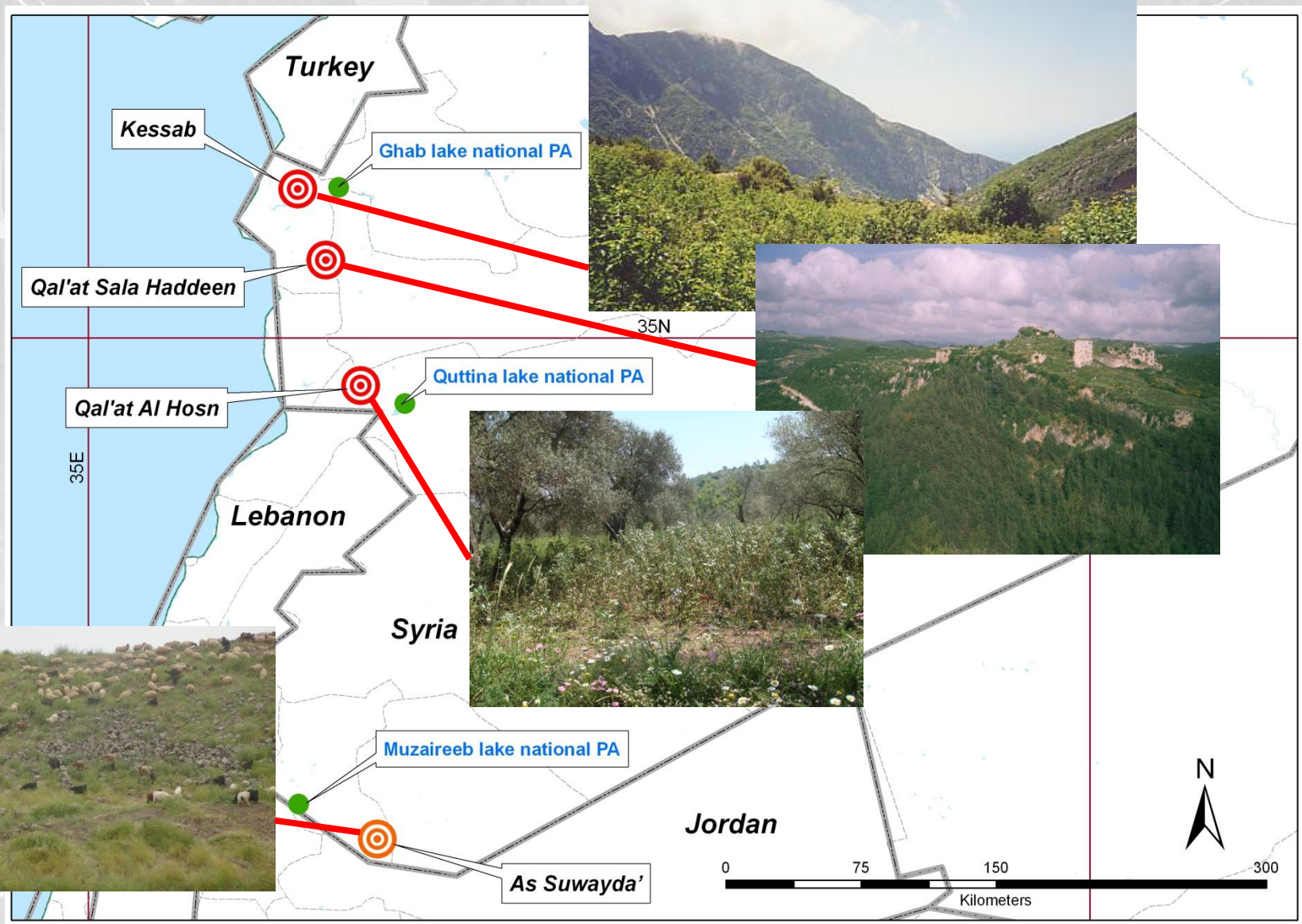
2.Complementarity analysis of multiple gene pools shows priority location overlap (making possible multi-gene pool sites for *in situ* conservation)

3.All species and priority species complementarity analysis results can be different

Qal'at al Hosn, Tel Kalkh, Homs Province, Syria

Analysis: Temperate Legumes

Complementarity Analysis of priority *Cicer*, *Lathyrus*, *Lens*, *Medicago*, *Pisum* and *Vicia* species

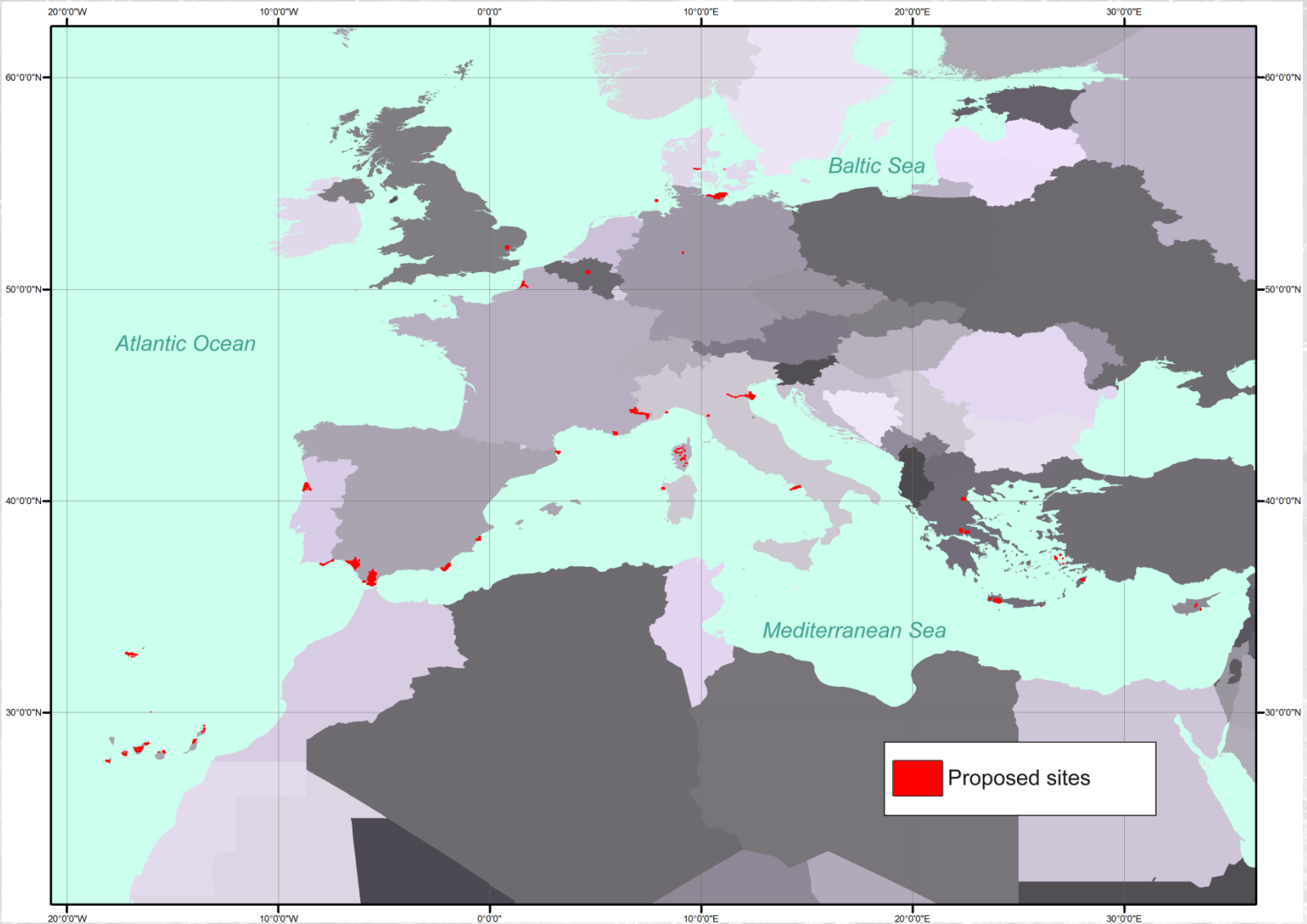


Analysis: Temperate Legumes

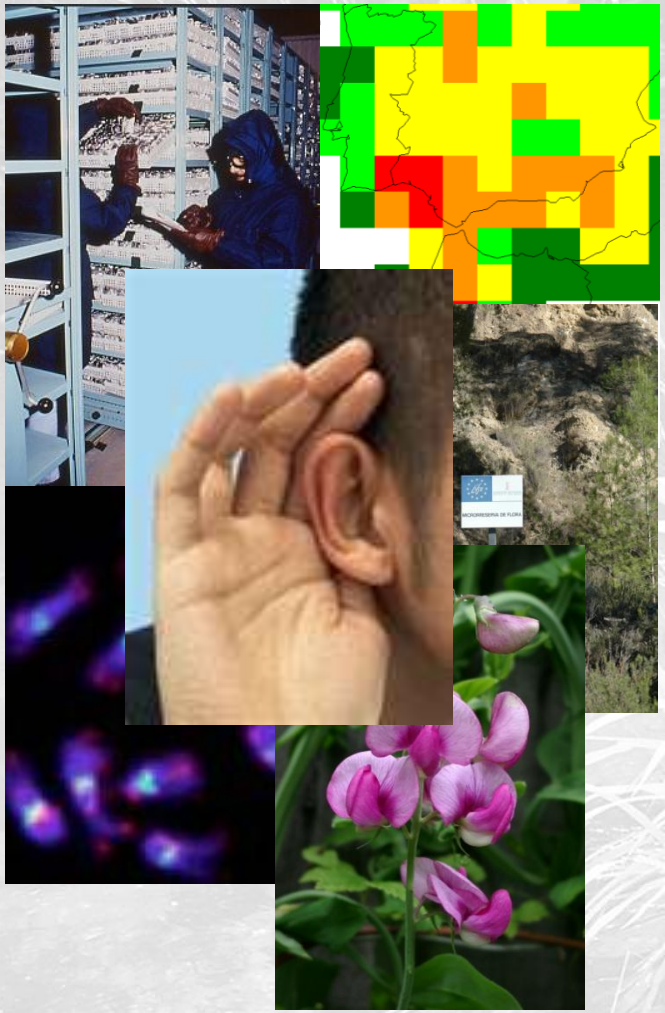
Next Steps -

- Further genetic gap analysis of cereal data
- Targeted *ex situ* collection
- Establishment of genetic reserves in existing protected areas
- Establishment of novel protected areas
- Integration of genetic reserves into FAO Global CWR Network

AEGRO: Similar analysis in Europe (*Avena*, *Beta*, *Brassica* and *Prunus*)



Take home messages!



- Temperate legume CWR diversity is a critical resource for food security and human well being!
- CWR diversity is seriously threatened
- Gap analysis is a useful technique to aid systematic and complementary *in situ* and *ex situ* conservation action
- Strengthen weak existing links between plant biodiversity and agro-biodiversity communities
- Enhanced use is as important as conservation—through use comes sustainability