From hundreds to dozens:

Potential alien pests identified by SOM analysis

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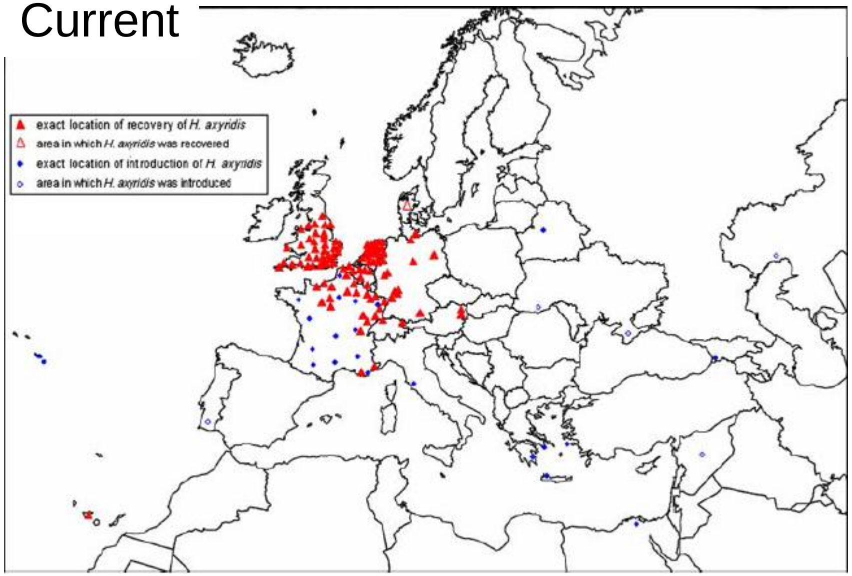
Presentation based on:

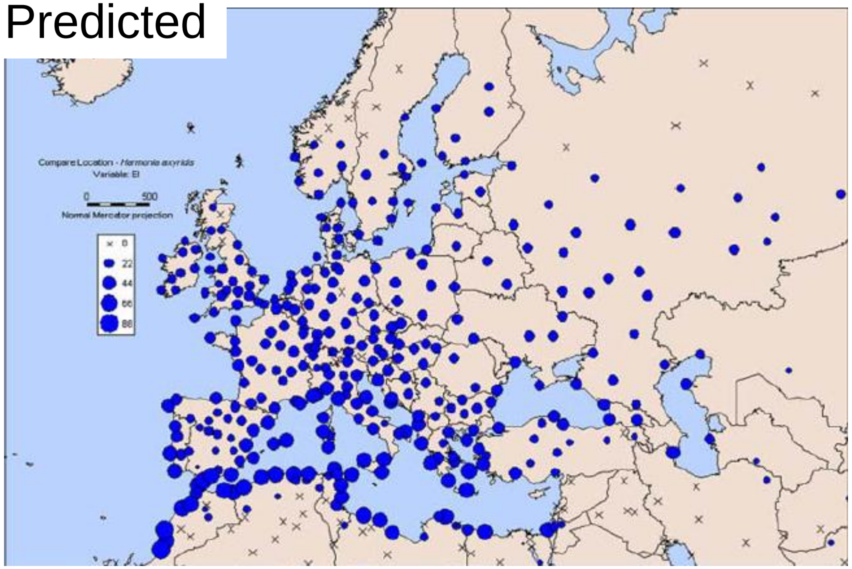
Vänninen, I., **Worner, S.,** Huusela-Veistola, E., Tuovinen, T., Nissinen, A., Saikkonen, K. 2011. Recorded and potential alien invertebrate pests in Finnish agriculture and horticulture. – *Agricultural and Food Science* 20, 1: 96-114.

Ecological niche models/Climex: potential distribution range of *Harmonia axyridis* in Europe (Poutsma et al. 2008. BioControl 53: 103-125)

Current



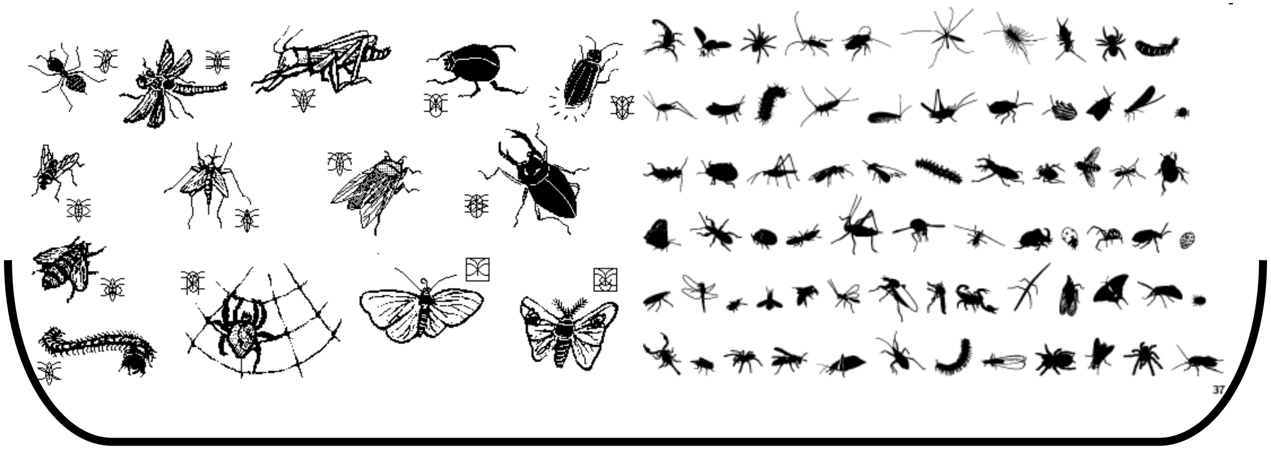
Predicted



http://scienceblogs.com/myrmecos/2008/10/ladybirds-flying.php

How to choose species from the pool of potential invaders for further scrutiny?

Species pool of potential introduced invasive species



Ecological niche models

Adding landscape and biotic factors

- inferring from interception data (reactive)
- observing which species are invasive elsewhere → expert judgement (reactive & proactive)
- **predicting in a pro-active manner for a given geographic area?**

Self-organizing map (SOM) and neural network method for prediction

Peacock L, Worner S. 2006. Using analogous climates and global insect distribution data to identify potential sources of new invasive insect pests in New Zealand. New Zealand Journal of Zoology 33: 141-145.

Gevrey M, Worner S, Kasabov N, Pitt J, Giraudel J.-L. 2006. Estimating risk of events using SOM models: A case study on invasive species establishment. Ecological Modelling 197: 361–372.

Gevrey M, Worner S. P. 2006. Prediction of global distribution of insect pest species in relation to climate by using an ecological informatics method. Journal of Economic Entomology 99(3): 979-986.

Paini DR, Worner SP, Cook DC, De Barro DJ, Thomas M. B. 2010. Using a self-organizing map to predict invasive species: sensitivity to data errors and a comparison with expert opinion. Journal of Applied Ecology 47: 290–298.

Self-organizing map: starting point is a matrix of georaphic sites and pest species to depict the occurrence of pests (1, 0) in an area (e.g. Finland)

Sample descriptors: geogr. area, pest species

	Species number												
Area	**1**	**2**	**3**	**4**	**.**	**.**	**.**	**839**	**840**	**841**	**842**	**843**	**844**
Norway													
Finland	1	1	1	0	.	.	.	1	1	1	0	0	0
Russia													
Austria													
New Zealand1													
New Zealand2													
Canada 1													
Canada 2													
Canada 3													
.													
.													
.													
Spain													
Morocco													
Brazil													

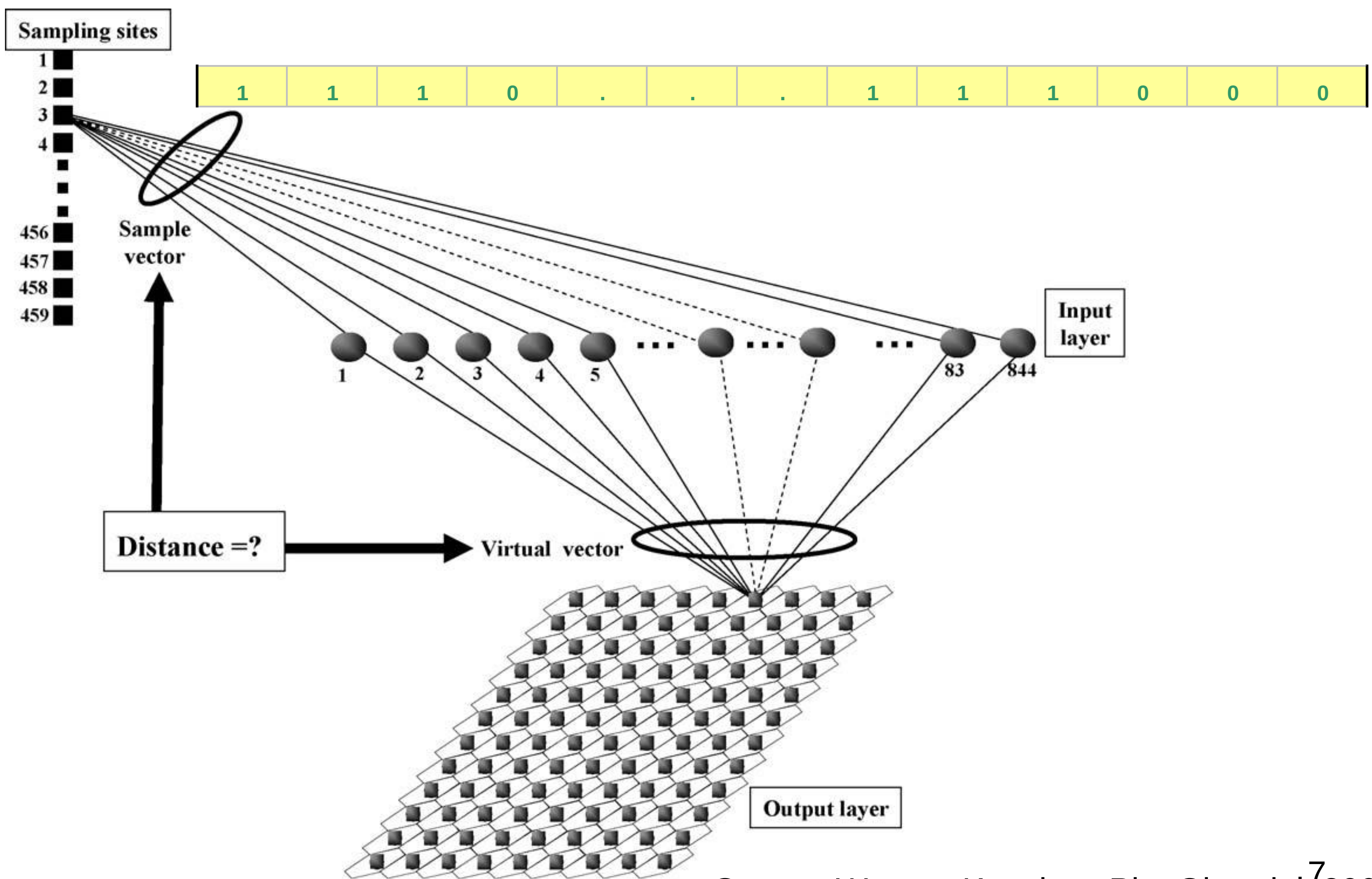
844 spec-ies

Sample vector n=459

459 sites

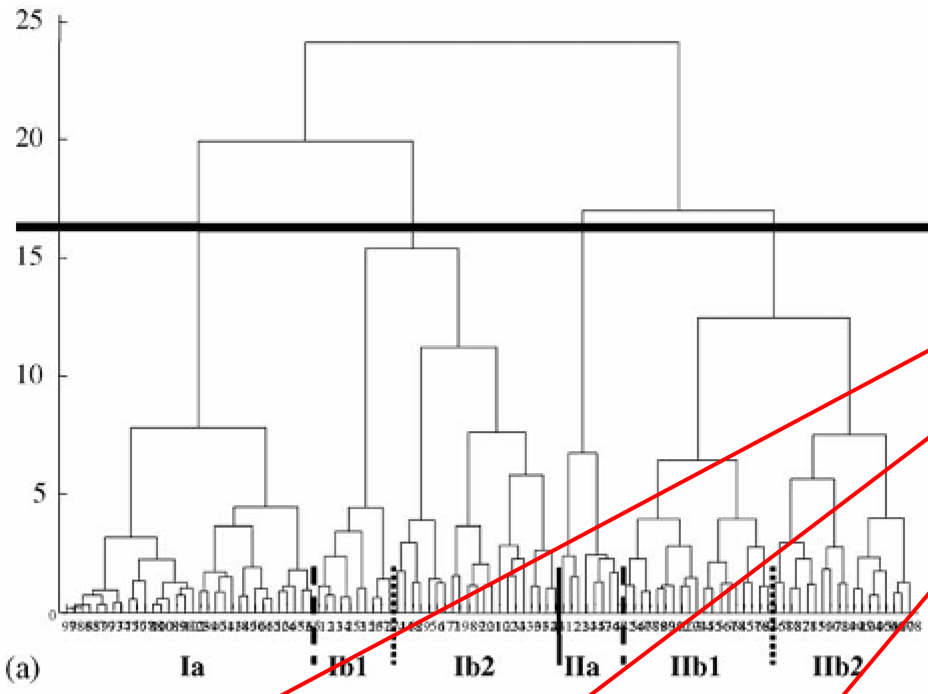
Pest database: CABI 2003. Crop Protection Compendium, Global Module, 5th ed. Wallingford, UK: CAB International.

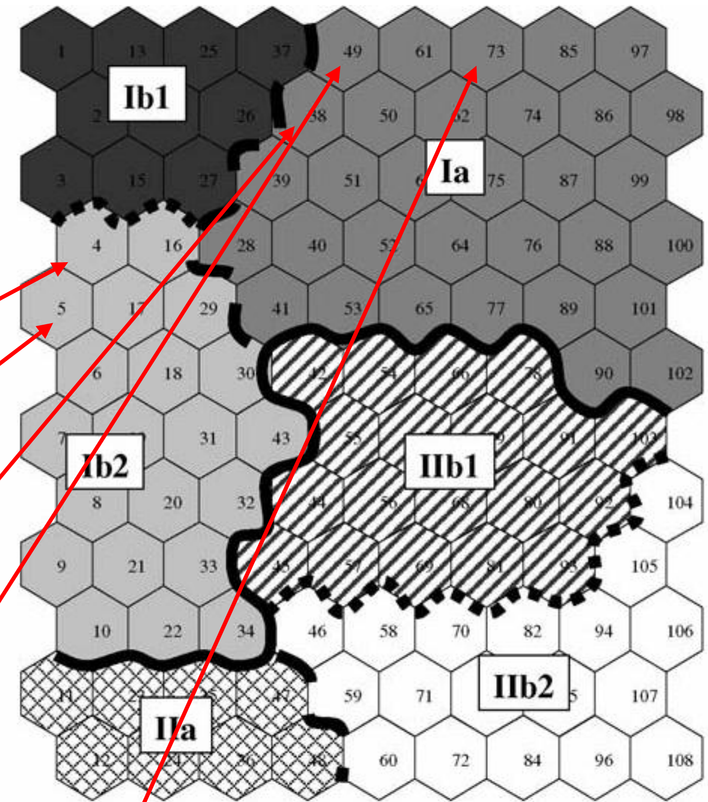
Producing a self-organizing map using a SOM-algorhitm



Gevrey, Worner, Kasabov, Pitt, Giraudel. 2006. Ecol. Modelling 19(7): 361-372.

Clustering the cells of the output layer based on the sample vectors (similarity of species assemblages)

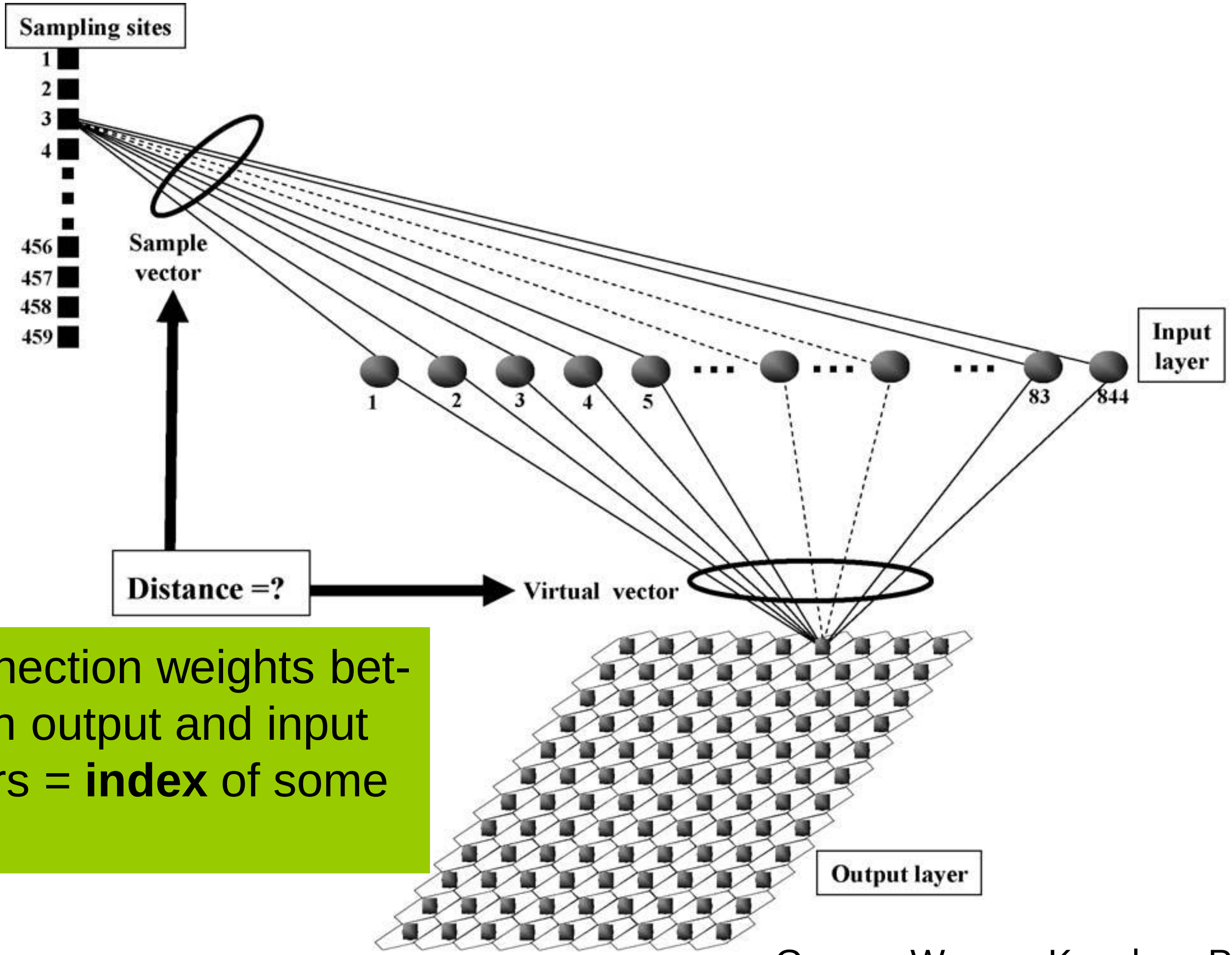




4 Norway
5 Finland, Denmark, Sweden, Poland, Germany
38 Lithuania, Latvia
49 Estonia
73 Iceland, Northern Russia

Gevrey, Worner, Kasabov, Pitt, Giraudel. 2006. Ecol. Modelling 19(7): 361-372.

Meaning of connection weights between sample and virtual vectors



Connection weights between output and input layers = **index** of some sort

Gevrey, Worner, Kasabov, Pitt, Giraudel. 2006. Ecol. Modelling 19(7): 361-372.

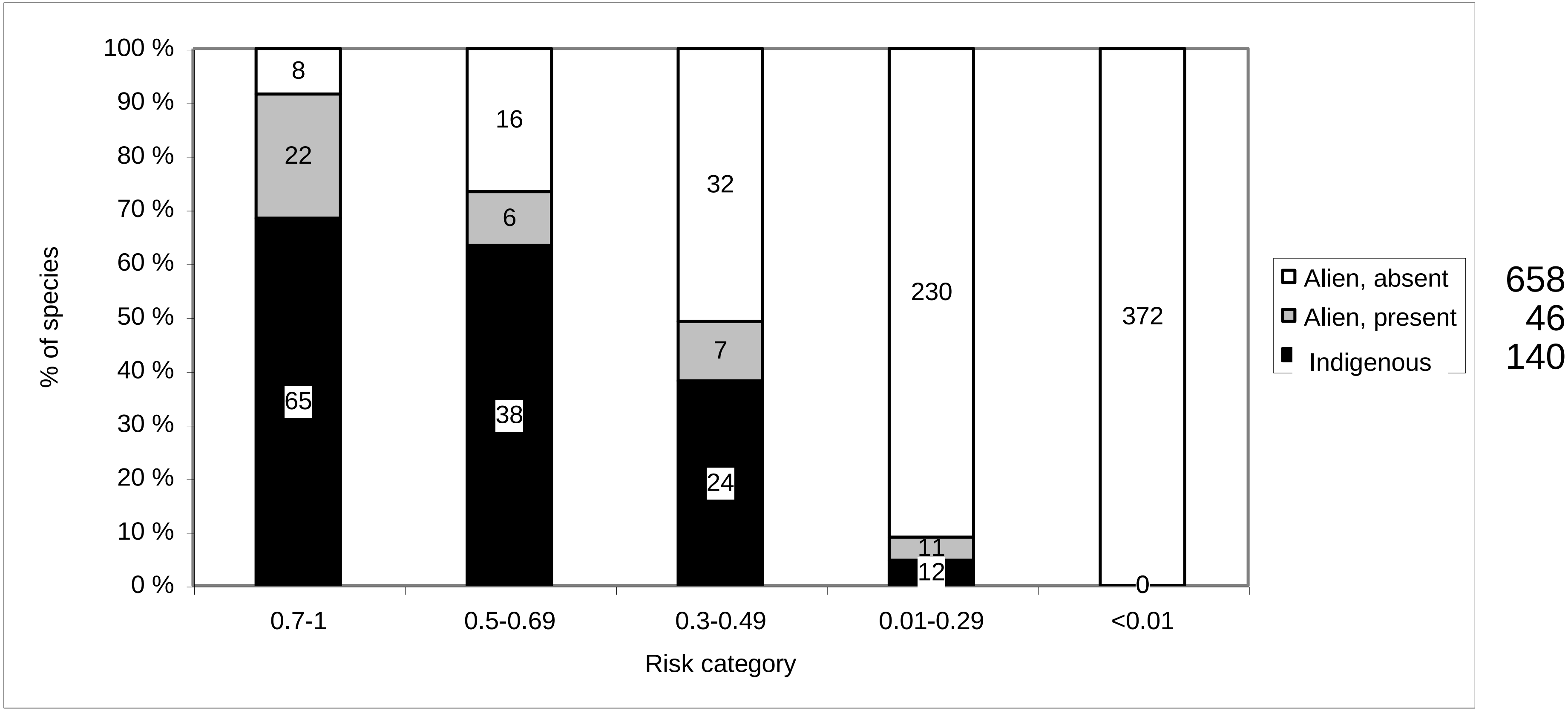
Indexes for the risk of establishment of given pest species in the study area

Gevrey, Worner, Kasabov, Pitt, Giraudel. 2006. Ecol. Modelling 19(7): 361-372.

Table 1 – List of the pest species out of a potential 844 which have the highest potential risk of invasion in New Zealand based on the SOM analysis

Name	code	risk	p/a	Name	code	risk	p/a
Planococcus citri*	PSECCI	0,93	1	Toxoptera aurantii	TOXOAU	0,49	1
Icerya purchasi	ICERPU	0,92	1	Taylorilygus pallidulus	TAYLPA	0,49	0
Myzus persicae	MYZUPE	0,87	1	Aleurothrixus floccosus	ALTHFL	0,48	0
Cydia pomonella	CARPPO	0,86	1	Pseudaulacaspis pentagona	PSEAPE	0,48	0
Nezara viridula	NEZAVI	0,85	1	Pieris rapae	PIERRA	0,47	1
Brevicoryne brassicae	BRVCBR	0,83	1	Hadula trifolii	SCOOTR	0,47	0
Delia platura	HYLEPL	0,80	1	Ephestia elutella	EPHEEL	0,47	1
Phthorimaea operculella	PHTOOP	0,79	1	Rhopalosiphum rufiabdominale	RHOPRU	0,46	1
Pseudococcus longispinus	PSECAD	0,79	1	Liriomyza trifolii	LIRITR	0,46	0
Aphis spiraecola	APHISI	0,77	1	Sitona discoideus	SITODI	0,46	1
Saissetia oleae	SAISOL	0,77	1	Spodoptera exigua	LAPHEG	0,46	0
Coccus hesperidum	COCCHE	0,77	1	Sitobion avenae	STOBAV	0,45	0
Aonidiella aurantii	AONDAU	0,76	1	Therioaphis trifolii	THAPTR	0,45	1
Eriosoma lanigerum	ERISLA	0,76	1	Locusta migratoria	LOCUMI	0,45	1
Aphis gossypii	APHIGO	0,76	1	Prays citri	PRAYCI	0,43	0
Viteus vitifoliae	VITEVI	0,75	1	Hippotion celerio	HPPOCE	0,43	1
Ceratitis capitata	CERTCA	0,73	0	Pantomorus cervinus	PANMCE	0,43	1
Agrotis ipsilon	AGROYP	0,73	1	Schizaphis graminum	SCZAGR	0,42	0
Bemisia tabaci	BEMITA	0,70	1	Oulema melanopus	LEMAME	0,42	0
Helicoverpa armigera	HELIAR	0,70	1	Scolytus rugulosus	SCOLRU	0,42	0
Acyrthosiphon pisum	ACYRON	0,70	1	Drosophila melanogaster	DROSME	0,42	0
Thrips tabaci	THRITB	0,69	1	Sitona lineatus	SITOLI	0,42	1
Saissetia coffeae	SAISHE	0,68	1	Mythimna unipuncta	PSEDUN	0,41	0
Rhopalosiphum maidis	RHOPMA	0,68	1	Pectinophora gossypiella	PECTGO	0,41	0
Plutella xylostella	PLUTMA	0,68	1	Hellula undalis	HLULUN	0,41	1

SOM-analysis for Finland: no. and % of pest species in different risk categories



For categorizing the risk levels, see Paini et al. 2010

Alien pest species present in Finland: 'prediction' power for outdoor, greenhouse and storage habitats:

Risk category	Species	Family (order)	Risk index	Habitat
0.7-1	Plutella xylostella	Plutellidae (Lep.)	0.9510	F
	Myzus persicae	Aphididae (Hom.)	0.9472	G
	Peridroma saucia	Noctuidae (Lep.)	0.9450	F
	Aphis gossypii	Aphididae (Hom.)	0.9064	G
	Otiorhynchus sulcatus	Curculionidae (Col.)	0.8711	F
	Pieris rapae	Pieridae (Lep.)	0.8704	F
	Frankliniella occidentalis	Thripidae (Thys.)	0.8635	G
	Heliothrips haemorrhoidalis	Thripidae (Thys.)	0.8259	G
	Rhopalosiphum insertum	Aphididae (Hem.)	0.8253	O
	Anthonomus pomorum	Curculionidae (Col.)	0.8172	O
	Agrius convolvuli	Noctuidae (Lep.)	0.8166	F
	Cacopsylla pyricola	Psyllidae (Hom.)	0.8154	O
	Rhopalosiphum maidis	Aphididae (Hem.)	0.8143	F
	Pieris brassicae	Noctuidae (Lep.)	0.7753	F
	Melolontha melolontha	Scarabeidae (Col.)	0.7728	F
	Malacosoma neustria	Noctuidae (Lep.)	0.7648	O
	Pseudococcus longispinus	Pseudococcidae (Hem.)	0.7507	G
	Aphis craccivora	Aphididae (Hom.)	0.7476	F
	Macrosiphum euphorbiae	Aphididae (Hom.)	0.7459	G
	Autographa gamma	Noctuidae (Lep.)	0.7309	F
	Ephestia elutella	Pyralidae (Lep.)	0.7107	S
0.5-0.69	Saissetia coffeae	Coccidae (Hem.)	0.6869	G
	Coccus hesperidum	Coccidae (Hem.)	0.6754	G
	Acanthoscelides obtectus	Bruchidae (Col.)	0.6183	S
	Ceutorhynchus assimilis	Curculionidae (Col.)	0.5429	F
	Planococcus citri	Pseudococcidae (Hem.)	0.5258	G
	Megastigmus spermotrophus	Torymidae (Hym.)	0.5113	O

Good 'prediction': outdoor habitats: all > 0.5

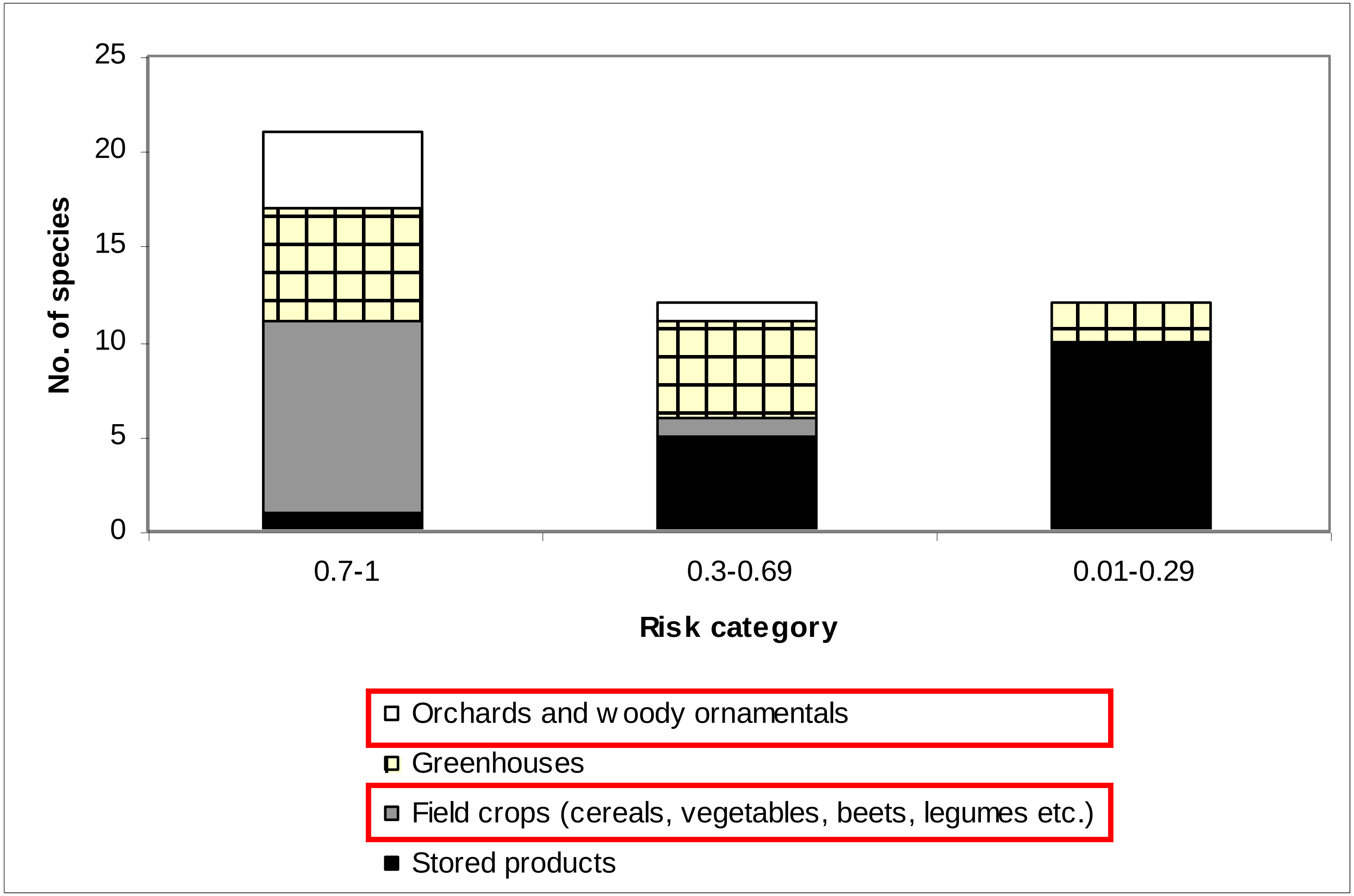
Mainly green-house

Alien pest species present in FI, cont.: 'prediction power for outdoor, greenhouse and storage habitats

0.3-0.49	**Saissetia oleae**	Coccidae (Hem.)	0.4605	G
	Trialeurodes vaporariorum	Aleyrodidae (Hem.)	0.4553	G
	Tribolium castaneum	Tenebrionidae (Col.)	0.3376	S
	Oryzaephilus surinamensis	Silvanidae (Col.)	0.3280	S
	Tribolium confusum	Tenebrionidae (Col.)	0.3249	S
	Cryptolestes pusillus	Cucujidae (Col.)	0.3082	S
0.01-0.29	Cryptolestes ferrugineus	Cucujidae (Col.)	0.2831	S
	Alphitobius diaperinus	Tenebrionidae (Col.)	0.2373	S
	Plodia interpunctella	Pyralidae (Lep.)	0.2228	S
	Tenebroides mauritanicus	Tenebrionidae (Col.)	0.1565	S
	Typhaea stercorea	Mycetophagidae (Col.)	0.1352	S
	Oryzaephilus mercator	Silvanidae (Col.)	0.1281	S
	Rhopalosiphum rufiabdominale	Aphididae (Hem.)	0.1073	G
	Galleria mellonella	Pyralidae (Lep.)	0.08578	S
	Trogoderma variabile	Dermestidae (Col.)	0.0853	S
	Ahasverus advena	Silvanidae (Col.)	0.0853	S
	Lasioderma serricorne	Anobiidae (Col.)	0.0620	S
	Macrosiphoniella sanborni	Aphididae (Hom.)	0.0427	G

Poor predictors: Indoors (storages): all < 0.5

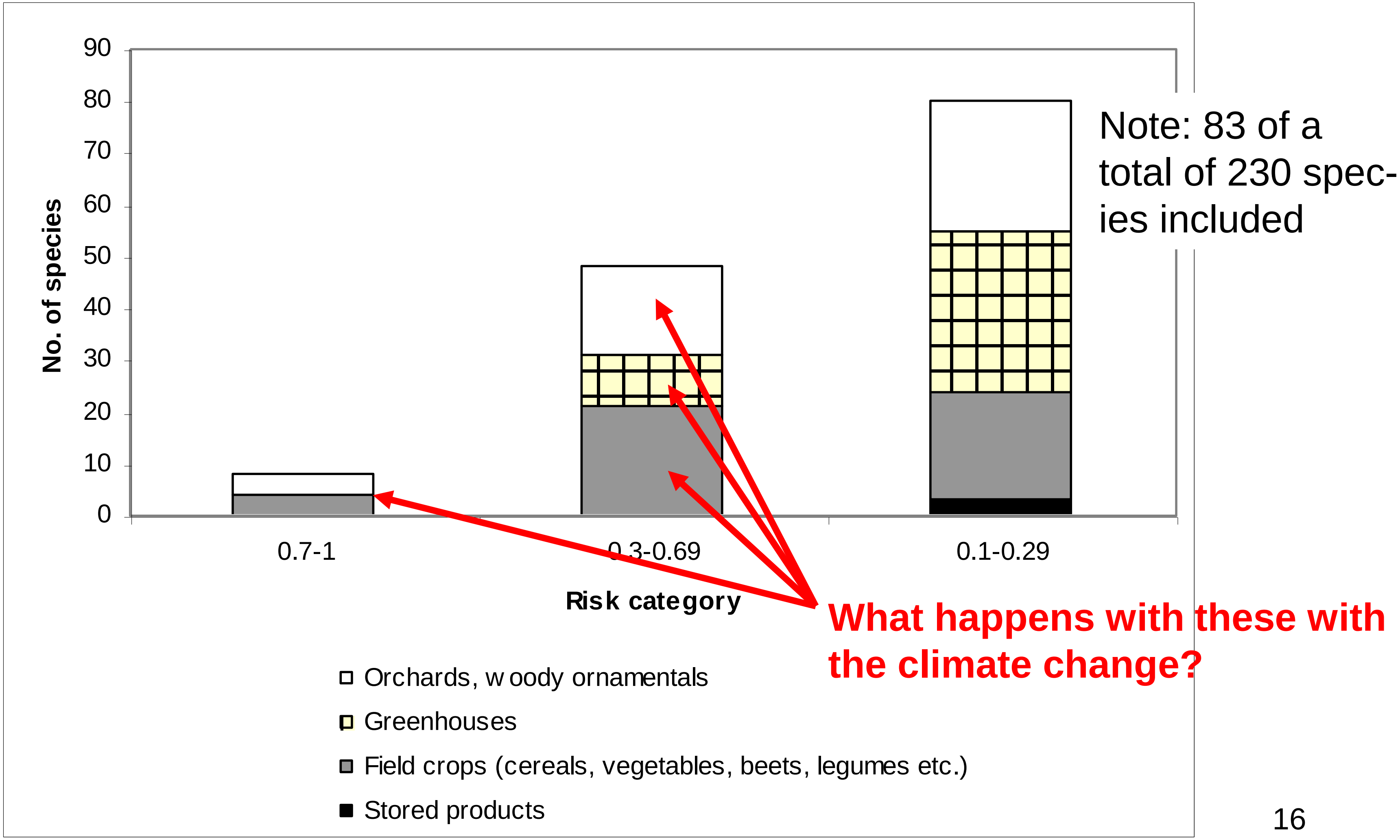
Alien pest species already present in Finland: habitats of established alien pest species vs. index for establishment risk



Risk index for establishment of currently not established pest species

Risk category	Species	Family (order)	Risk index	Habitat
0.7-1	Scolytus multistriatus	Scolytidae (Col.)	0.8798	O
	Eriosoma lanigerum	Pseudococcidae (Hem.)	0.8714	O
	Ostrinia nubilalis	Noctuidae (Lep.)	0.8224	F
	Parthenolecanium persicae	Diaspididae (Hem.)	0.7987	O
	Phyllotreta cruciferae	Nitidulidae (Col.)	0.7943	F
	Scolytus scolytus	Scolytidae (Col.)	0.7315	O
	Locusta migratoria	Acrididae (Orth.)	0.7228	F
	Leptinotarsa decemlineata	Chrysomelidae (Col.)	0.7108	F
0.5-0.69	Cephus pygmeus	Cephidae (Hym.)	0.6784	F
	Euproctis chrysorrhoea	Lymantriidae (Lep.)	0.6598	O
	Bemisia tabaci	Aleyrodidae (Hem.)	0.6587	G
	Hippotion celerio	Sphingidae (Lep.)	0.6365	F
	Diaspidiotus perniciosus	Diaspididae (Hem.)	0.6075	O
	Scrobipalpa ocellatella	Gelechiidae (Lep.)	0.6031	F
	Hyphantria cunea	Arctiidae (Lep.)	0.5930	O
	Viteus vitifoliae	Phylloxeridae (Hom.)	0.5852	G
	Cnephasia longana	Tortricidae (Lep.)	0.5554	F
	Mythimna unipuncta	Noctuidae (Lep.)	0.5505	F
	Zeuzera pyrina	Cossidae (Lep.)	0.5483	O
	Liriomyza huidobrensis	Agromyzidae (Dipt.)	0.5396	G
	Epidiaspis leperii	Diaspididae (Hem.)	0.5382	O
	Grapholita molesta	Tortricidae (Lep.)	0.5319	O
	Mythimna loreyi	Noctuidae (Lep.)	0.5084	F
	Ceresa alta	Membracidae (Auch.)	0.5028	O

Potential habitats of alien pest species not established yet in FI



Prediction for risk of greenhouse pest establishment is problematic

Species	Risk index for establishment	P/A*
Tuta absoluta	0.0000033	**A**
Liriomyza sativae	0.039700	A
Thrips palmi	0.042652	A
Bemisia tabaci B-biotype	0.2655	A
Helicoverpa armigera	0.3061	A
Cacoecimorpha pronubana	0.3858	A
Orthezia insignis	0.4192	A
Liriomyza trifolii	0.4596	A
Thrips simplex	0.4885	A
Liriomyza huidobrensis	0.53964	A
Bemisia tabaci	0.65868	A
Saissetia oleae	0.4605	P
Trialeurodes vaporariorum	0.5028	P
Planococcus citri	0.5258	P
Saissetia coffeae	0.6869	P
Frankliniella occidentalis	0.8635	P
Aphis gossypii	0.9064	P
Myzus persicae	0.9472	P

P=currently present (established)
A=absent and eradicated upon interception or outbreak

Risk of establishment indexes for regulated pests

2A	Coleoptera	Cerambycidae	*Anoplophora malasiaca*	0.009517
2A	Coleoptera	Chrysomelidae	*Diabrotica virgifera*	0.43867
2A	Diptera	Tephritidae	*Rhagoletis completa*	0.12115
2A	Hemiptera	Diaspididae	*Pseudaulacaspis pentagona*	0.42449
2A	Hemiptera	Aleyrodidae	*Aleurothrixus flocculosus (floccosus)*	0.13691
2A	Hemiptera	Coccidae	*Parasaissetia nigra (syn. Saissetia nigra)*	0.07257
2A	Lepidoptera	Gelechiidae	*Tuta absoluta*	0.0000033
2A	Lepidoptera	Gelechiidae	*Phthorimaea operculella*	0.24627
2A	Lepidoptera	Tortricidae	*Grapholita inopinata*	0.00000022
2AB	Coleoptera	Cerambycidae	*Anoplophora chinensis*	0.074294
2AB	Coleoptera	Scarabeidae	*Popillia japonica*	0.088543
2AB	Hemiptera	Diaspididae	*Diaspidiotus (Quadraspidiotus) perniciosus*	0.6075
2AB	Hemiptera	Aleyrodidae	*Aleurocanthus spp. (A. spiniferus)*	0.005878
2AB	Hemiptera	Diaspididae	*(Lopho)leucaspis japonica*	0.095409
2AB	Hemiptera	Aphididae	*Toxoptera citricida*	0.000434
2AB	Lepidoptera	Tineidae	*Opogona sacchari*	0.14721
2AB	Lepidoptera	Carposinidae	*Carposina niponensis*	0.00000038
2AB	Thysanoptera	Thripidae	*Scirtothrips dorsalis*	0.0000000004
2B	Lepidoptera	Lasiocampidae	*Dendrolimus superans sibiricus*	0.0000003

Conclusions

- SOM-method = feasible for reducing the search space of the pool of species with potential risk of establishment
- The indexes for risk of establishment can be used be used e.g. supporting where to focus phytosanitary measures and decision-making concerning monitoring and further, more detailed research employing climate envelope modelling
- The lists must be complemented with other means of predicting risk of establishment:
  - database used in the analysis is not complete for all pests
  - the risk indexes seem to be most reliable to outdoor pests

Conclusions

- In Finland in current climatic conditions: 0.5 seems to be the threshold risk index that indicates possibility of the species establishing in outdoor crops
- The species in the highest risk category (>0.5) could be analysed further assuming changed climatic conditions
- The prevalence of a given pest in the database and in different areas must be taken into account when making conclusions – if there are many observations for a pest from a given geograph. area this can distort the values the method calculates for it.

Thank you for your attention