ALARM project: Assessing Large-scale risks to biodiversity with tested methods

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Overview

Context/problem to be solved
- Several studies indicate local loss of pollinators in several regions across Europe but data is lacking at the continental level.
- Insufficient pollination services have been described in some European crops and wild plants, however, it is unknown how widespread this phenomenon is.
- A variety of drivers of pollinator loss have been identified, yet there is little information on the relative importance of these drivers at large spatial scales.
- The socio-economic benefits of pollination services in Europe have been studied in only a few specific cases and a quantitative evaluation is lacking.
- There are no standardised methods for assessing pollinator diversity and pollination services.

Objectives
- Development of standardised protocols for pollinator biodiversity and pollination services.
- Establishment of long-term monitoring schemes across Europe.
- Quantification of pollination requirements of key European crops and wild plants.
- Production of a European pressure and impact risk assessment map.
- Identification of vulnerable ecosystem types, risk zones and pollinator groups.
- Development of predictive models for pollinator risk assessment.
- Identification of the drivers of pollinator loss at the local, national, and continental level and an understanding of the synergism between drivers at different scales.

Approach
The ALARM project (Assessing LArge-scale Environmental Risks to Biodiversity with Tested Methods; http://www.alarm-project.ufz.de/) is a European Framework 6 Integrated Project which will run 2004 – 2009. The consortium comprises 54 partner institutions from 26 countries and will undertake an integrated risk assessment across Europe with particular emphasis on: pollinator loss, climate change, invasive species and environmental chemicals.

Application of the ecosystem approach
The ecosystem approach is integral to the entire ALARM project through:
- Generation of knowledge to direct management of pollinator resources to benefit society.
- Consideration of both agro-ecosystems and semi-natural areas and how these impact upon each other.
- Recognition of the need to reconcile the conflict between production value in insect pollinated crops and the conservation of pollinator biodiversity.
- Studying ecosystem structure and function across a range of spatial and temporal scales.
- Using a multi-disciplinary approach integrating natural sciences with socio-economics in conjunction with a range of stakeholders and end-users.

Lessons learnt.
Loss of pollinator biodiversity and pollination services is potentially a continental-scale problem and a highly integrated and multi-disciplinary project across Europe is the appropriate approach to deal with this issue. Over the next decade ALARM will disseminate a series of databases, toolkits, recommendations and other materials to the European community to help secure pollination services and maximize the long-term socio-economic benefits to society.

I. Background/Problem statement:

Europe's pollinators are all insects and there are several studies describing declines of particular species or restricted taxa in specific regions of Europe, but at this time there is no continental-scale assessment of pollinator loss. Several studies have identified the causes of pollinator declines in restricted localities but the range, relative importance and possible interaction of these drivers is unknown. There are many specific reports describing reduced pollination services to both crops and wild flowers, but for most crops and wild flowers the main pollinators are not known. This growing body of evidence suggest that the loss of pollinators and services may be a widespread problem.

The European Union identified pollinator loss and three other environmental risks (climate change, invasive species and environmental chemicals) as high priorities for research funding under the Framework 6 Programme (http://fp6.cordis.lu/fp6/home.cfm). An open call for projects was made in 2003 and the ALARM consortium (Assessing LArge-scale Environmental Risks to Biodiversity with Tested Methods) won the contract (GOCE-CT-2003-506675). Research will focus on assessment and forecast of changes in biodiversity and in structure, function, and dynamics of ecosystems. This relates to ecosystem services and includes the relationship between society, economy and biodiversity. In particular, risks arising from pollinator loss, climate change, environmental chemicals and biological invasions in the context of current and future European land use patterns will be assessed.

The ALARM consortium comprises four independent modules assessing risks consequent on: Pollinator loss, Climate change, Invasive species and Environmental chemicals (Figure 1). These four modules are integrated into a cohesive research programme through a series of 'cross-cutting' links which include socio-economics and land use patterns.

Figure 1. Organisation of the ALARM project.
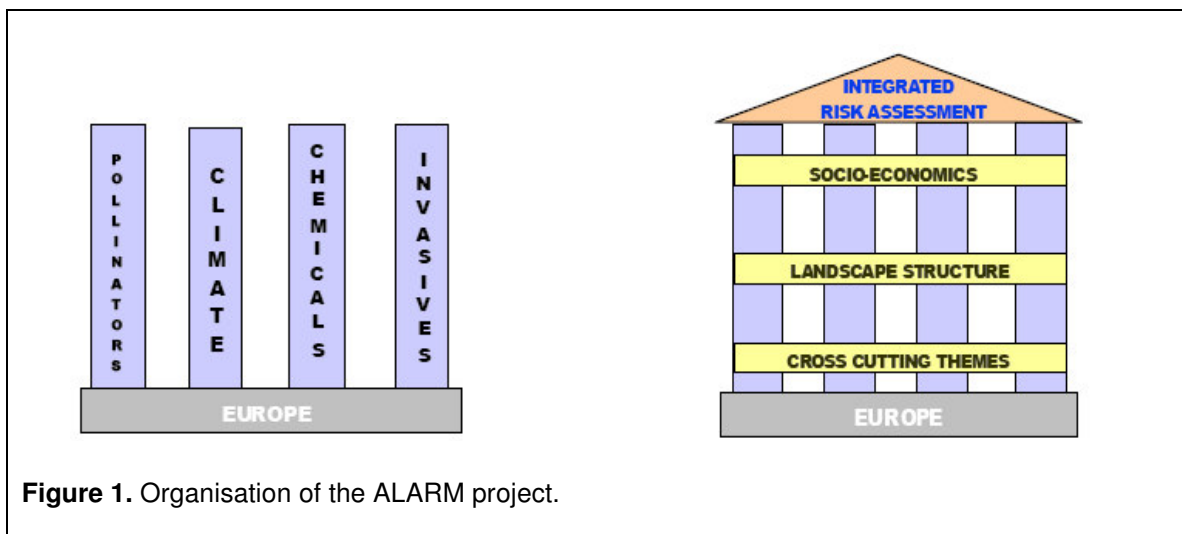
With respect to pollinators, ALARM will identify indicator groups to develop thresholds for the quantification of: (1) pressure (probability of pollinator loss) linked with (2) impact (consequences of loss of pollination function). This ecological basis for risk assessment will use a package of standardized protocols developed to allow comparable assessments to be undertaken in different ecosystems and in different EU regions. Specific scientific and technological innovations include:
- Development of rigorously standardised protocols for pollinator abundance, diversity and pollination services to agricultural crops and wild plants.
- Establishment of long-term monitoring schemes across Europe.
- Quantification of pollination requirements of key European crops and wild plants.
- Building a definitive catalogue of pollinator taxa and functional groups with regionally

relevant risk probability evaluations.
- Production of a European (and first continental scale) pressure and impact risk assessment map.
- Identification of vulnerable ecosystem types, risk zones and pollinator groups.
- Development of predictive models for pollinator risk assessment.
- Identification of the drivers of pollinator loss at the local, national, and continental level and an understanding of the synergism between drivers at different scales.

II. Objectives/Purpose of the Activities:

The general objectives of ALARM are to:
- Develop an integrated large scale risk assessment to biodiversity as well as terrestrial (and freshwater) ecosystems as a part of environmental risk assessment.
- Focus on risks consequent on climate change, environmental chemicals, rates and extent of loss of pollinators and biological invasions including pathogens.
- Establish socio-economic risk indicators related to the drivers of biodiversity pressures as a tool to support long-term oriented mitigating policies and to monitor their implementation.
- Develop, for the first time, a research network that is consistently thinking, interacting, and investigating on a continental scale across different environmental problem (impacts) and across different spatial and temporal scales of ecosystem diversity changes.
- Provide a contribution to objective based politics, to policy integration and to derive outcome-oriented policy measures in the field of biodiversity preservation by contributing to the integrated assessment of socio-economic drivers affecting biodiversity and integrated, long-term oriented means to mitigate them.

III. Details of the case study and the approach taken:

The ALARM work programme is divided into two broad and complementary blocks. The first aims to assess the risk probability of losing pollinators across Europe and the second focuses on the impact of this loss on ecosystems services i.e. pollination.

Assessing the risk probability of pollinator decline
To determine the risk of losing pollinators and make future predictions it is necessary to quantify the distribution shifts in key pollinator groups across Europe. ALARM will realize this through three approaches: (1) Data Mining; (2) Repeating Historical Observations; and (3) Developing Standardised Methods .

Impact on Pollination Services
In addition to understanding distribution changes in pollinators it is essential to quantify changes in the function of pollinators in providing ecosystem services. Changes in the pollination services to both crops and wild plant systems have important socio-economic and biodiversity implications. Three tasks are being undertaken to assess the consequences of pollinator loss on pollination services: (1) development of standardised methods to measure pollination limitation; (2) quantification of pollination failure in natural, and (3) agricultural ecosystems.

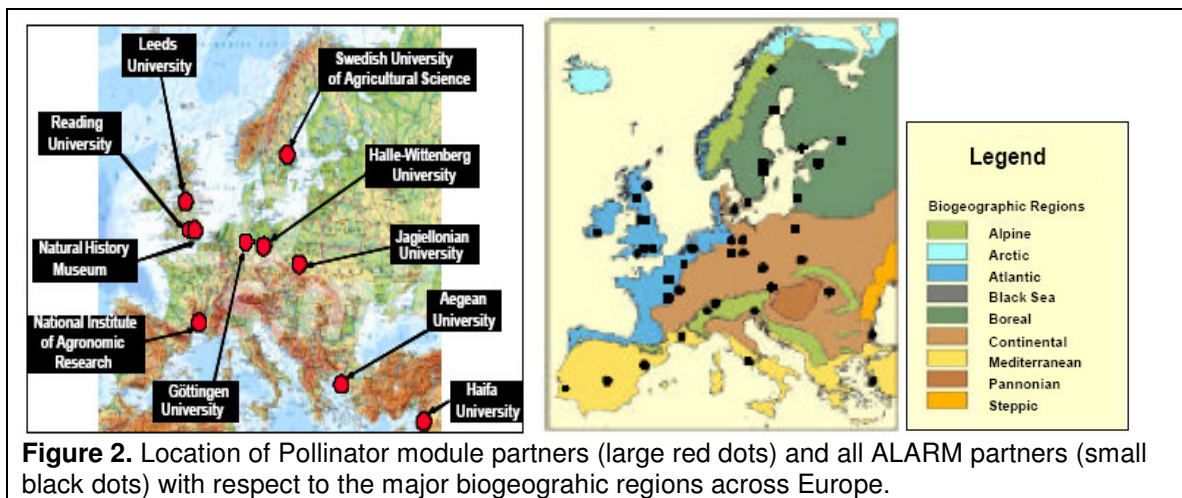*Assessing Multiple Environmental Risks to Pollinators*
Our understanding of the environmental drivers of pollinator loss comes from a series of case studies with limited value for large-scale risk assessment. Even though most of continental

Europe has not been assessed for pollinator loss, declines are likely to be widespread as the known drivers of loss are also widespread. ALARM will quantify the relative importance and combined effects of the main drivers of pollinator shifts (habitat loss, climate change, invasive species, agro-chemicals, pests and diseases) and their consequences on ecosystem functions. This will be approached in two ways: establishing a pan-European focal site network and by examining the interactions between pollinator loss and potential drivers both on their own and in combination.

Testing Predictions for Pollinator and Ecosystem Function Loss
ALARM will produce high quality data sets relating to European-scale pollinator distributions and provision of pollination services. A key requirement for the testing of large-scale risk assessment predictions is the identification of pollinator, floral and habitat traits associated with increased risk. This is necessary to underpin the construction of prediction maps indicating European areas most likely to experience loss of pollinators and consequent ecosystem function. Risk criteria are likely to be related to pollinator species traits (e.g. taxa, body size, degree of specialisation etc.); flower species traits (e.g. taxa, breeding system, flowering period etc.) and also site traits (e.g. latitude, longitude, elevation, habitat, landscape structure, degree of disturbance). Site and species risk criteria may interact; for instance, certain pollinator groups may be at risk in particular habitats, whereas other species may thrive under the same conditions. Such criteria may allow conclusions to be drawn as to which European pollinators and pollination systems are most vulnerable and therefore need of protecting and conserving.

Lead partners for the Pollination Module of ALARM (Figure 2.)

Figure 2. Location of Pollinator module partners (large red dots) and all ALARM partners (small black dots) with respect to the major biogeograhic regions across Europe.

- Göttingen University (Germany): Department of Agroecology, Dr. Ingolf Steffan-Dewenter, Dr Catrin Westphal and Birgit Meyer
- Aegean University (Greece): Department of Geography, Prof. Theodora Petanidou, Dr Ellen Lamborn and Olivia Messenger.
- Reading University (UK): Centre for Agri-Environmental Research, Dr. Simon G. Potts and Mr. Stuart Roberts
- Institut National de la Recherche Agronomique (France): Laboratoire de Pollinisation Entomophile, Dr. Bernard Vaissière and Gabriel Carre
- Leeds University (UK): Centre for Biodiversity and Conservation, Dr. Bill Kunin and Dr Koos Biesmeijer
- Natural History Museum (UK): Department of Entomology, Dr Andy Polaszek, Mr. George Else and Dr Paul Williams
- Haifa University (Israel): Laboratory of Pollination Ecology, Prof. Amots Dafni and Dr Gidi Ne'eman

- Jagiellonian University (Poland): Prof. Michal Woyciechowski
- Swedish University of Agricultural Science (Sweden): Prof. Jan Bengtsson and Dr Riccardo Bommarco
- Halle-Wittenberg University (Germany): Prof Robin Moritz and Dr Bernd Kraus
- Oxford University Museum (UK): Mr. Chris O'Toole and Dr Mark O'Neill

The ALARM consortium includes 54 partners in total (see http://www.alarm-project.ufz.de/)

V. Analysis:

Application of the ecosystem approach
ALARM encompasses most of the principles of the ecosystem approach:
- Principles 1, 11 and 12: The consortium includes and interacts with a broad cross-section of European society to undertake research and deliver findings to relevant end-users and stakeholders.
- Principle 2: Dissemination of output will include recommendations for decentralized management wherever appropriate.
- Principle 3: Assessments of pollinator loss includes all major terrestrial ecosystems found in Europe with landscape context being a core theme.
- Principle 4: ALARM will attempt to: identify those replacement land-use systems causing loss of pollinator biodiversity; assign more realistic economic values to the services provided by pollination; quantify the drivers of pollinator loss and locate those responsible for environmental costs.
- Principle 5: Quantifying pollinator biodiversity and pollination service provision across Europe is one of the key steps towards the conservation and sustainable management of pollinators.
- Principles 7 and 8: Risk assessments cover a broad range of spatial (habitat, region, continent) and temporal (seasonal, annual, decadal) scales.
- Principle 9: ALARM works from the basis that all ecosystems are dynamic and will potentially change, especially in response to increasing anthropogenic activities.
- Principle 10: Understanding the biodiversity and economic value of pollinators is central to the project and will support the resolution of the potential conflict between production value and conservation.

Relevance to the operational objectives of the Plan of Action of the IPI
The stated objectives of the IPI and ALARM are congruous with the former having a global perspective and the latter a European perspective. ALARM is and will be:

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- Assessing the status of European pollinators and investigating the drivers of observed declines.
- Identifying land management practices and policies benefiting/threatening pollinators and pollination services.
- Directing future resources towards those individuals, organizations where support will have the greatest benefits for agricultural biodiversity.
- Informing local and national biodiversity on priority pollinators and habitats for conservation.
- Increasing public, stakeholder and end-user awareness of the value of pollinators.

Relevance to the cross-cutting work programmes of the Convention
ALARM has high relevance to several cross-cutting themes, namely:
- The project includes a specific module undertaking a pan-European invasive alien species

risk assessment and research will address issues associated with the interaction of invasives with pollinators.

- The main activity of the pollination module during 2004 was testing methods to rapidly, effectively and reliably assess pollinator diversity and services. The identification of potential <u>indicators</u> is currently being addressed.
- <u>Impact assessment</u> is the core of ALARM and is the first project to undertake this at a continental level.
- ALARM has further highlighted the <u>taxonomic deficit</u> for pollinators in Europe. Identification of pollinators is a clear bottleneck and the project is running a bee workshop and developing an interactive digital generic key for European bees.
- Outputs from the project will be used to inform, direct and support policy development, education and awareness for the need to conserve and sustainably manage pollinators.

V. Conclusions.

To effectively address the risks associated with pollinator loss, climate change, invasive species and environmental chemicals, three key elements are required: appropriate scale, expertise and integration. Environmental risks are widespread and therefore a continental (global) approach is needed using a broad range of state-of-the-art expertise which operates in a highly coordinated and integrated manner. This is the core of ALARM, and over the next few years the project will produce a number of specific deliverables including:

- Toolkit of standardised methods to assess pollinator biodiversity and pollination services.
- Biodiversity and economic assessment of the value of pollinators across Europe.
- Integrated European pollinator database.
- Quantification of drivers of pollinator loss.
- Predictive models for pollinator declines
- Contribution to a knowledge base to underpin future activities (adaptive management, capacity building and mainstreaming).