PROJECT TITLE

Could Biodiversity Assure Weed regulAtion for Resilient Ecosystem service provision?

TOPIC

Topic A2: Integrated, sustainable and resilient Cropping systems (RESCROPS)

YOUR PROJECT IS RELATED TO

Topic A2: Integrated, sustainable and resilient Cropping systems (RESCROPS)
Topic B1: Innovative direct biological control methods in holistic IPM approach (INDIBICOM-IPM)

PROJECT DURATION	TOTAL REQUESTED FUNDING	TOTAL COSTS
36 Months	856.975 €	1.147.602 €

CONSORTIUM

P 1	Dr David Bohan INRA	17, Rue Sully, 21000 Dijon France	David.Bohan@dijon.inra.fr Tel.: 0033 3 80 69 33 45 Mobile: 0033 6 95 08 65 19 Fax: 0033 3 80 69 32 62 http://www.inra.fr
P 2	Prof Michael Traugott University of Innsbruck	Technikerstrasse 25, 6020 Innsbruck Austria	Michael.Traugott@uibk.ac.at Tel.: 0043 512 507 51670 Mobile: 0043 650 6917493 http://www.uibk.ac.at/ecology/staff/persons/traugott.html.en
P 3	Dr Mattias Jonsson Swedish University of Agricultural Sciences	Ulls väg 16, P.O. Box 7044, SE-750 07 Uppsala Sweden	mattias.jonsson@slu.se Tel.: 0046 725326556 Mobile: 0046 725326556 Fax: 0046 18672890 http://www.slu.se
P 4	Dr Pavel Saska Crop Research Institute	Drnovská, 507, 161 06 Prague 6 - Ruzyně Czech Republic	saska@vurv.cz Tel.: 00420 233022416 Mobile: 00420 702087638 Fax: 00420 233311591 http://www.vurv.cz
P 5	Dr Wopke van der Werf Wageningen University	Droevendaalsesteeg 1, 6708PB Wageningen The Netherlands	wopke.vanderwerf@wur.nl Tel.: 0031 317484765 Mobile: 0031 623251921 Fax: 0031 317484892 https://www.wageningenur.nl/en/Persons/Wopke-van-der-Werf.htm

KEYWORDS

Pre-defined keywords	sustainable, resilient, pests
Supplementary keywords	insurance hypothesis, natural weed regulation, ecosystem service, food webs, farmer-acceptable IPM solutions

PARTNER DATA

Partner 1 (Consortium Coordinator): INRA

FINANCE COMMENTS

Personnel	With the revised funding to be used for this project, we request funds for a Post-doc (24 months) to conduct the meta-analysis, conduct the co-development work and run the demonstration network transferred from WU. This will include supervising, as appropriate, the demonstration network in Austria. As previously, a Ph.D. student (36 months) and six research students are requested. The research students (Master grade) will each do a 6-month placement as part of WP3 (one in France, one in Sweden and one in Austria for two successive years).
Travel	12 k€ is requested for travel during the project. This will include the travel and subsistence necessary to run meetings with partners, but also field site visits and the visits to Sweden and Austria for the DCE surveys as part of WP3.
Consumables / Equipment	35 k€ is requested for consumables and equipment costs as part of the project. These costs include conducting the molecular trophic analyses for reconstructing weed seed predation networks in France and all the weed seedbank germination. Costs are also requested for a Vortis suction sampler.
Subcontracts	An increase of 5k€ in the sub-contract (now 20k€) for Solagro is requested to take into account the extra work to be done for the demonstration network.
Other	

TASK(S)

Project coordination and management of sub-contract to Solagro
Lead and manage project work in France
Conduct field experiment in France
Develop the socio-economic discrete-choice experimental approaches
Consolidate existing data and conduct meta-analyses for publication
Co-develop and demonstrate farmer-acceptable IPM strategies for weed control in the EU

LITERATURE REFERENCES

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  Basic and Applied Ecology (), (in press)
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- Petit, S., Boursault, A. & Bohan, D.A.

Weed seed choice by carabid beetles (Coleoptera: Carabidae): Linking field measurements with laboratory diet assessments
European Journal of Entomology (111), 615-620 (2014)
- Pocock, M.J.O., Evans, D.M., Fontaine, C., Harvey, M., Julliard, R., McLaughlin, Ó., Silvertown, J., Tamaddoni-Nezhad, A., White, P.C.L. & Bohan, D.A.
The Visualisation of Ecological Networks, and Their Use as a Tool for Engagement, Advocacy and Management
Advances in Ecological Research (54), 41-85 (2016)
- Vacher, C., Tamaddoni-Nezhad, A., Kamenova, S., Peyrard, N., Moalic, Y., Sabbadin, R., Schwaller, L., Chiquet, J., Alex Smith, M., Vallance, J., Fievet, V., Jakuschkin, B. & Bohan, D.A.
Learning Ecological Networks from Next-Generation Sequencing Data
Advances in Ecological Research (54), 1-39 (2016)

ADDITIONAL FIELDS

Organisation acronym	INRA
Funding agency	MAAF

Partner 2: University of Innsbruck

FINANCE COMMENTS

Personnel	With the revised funding of this project, we request 100% salary for a PhD student for three years and a personnel budget for technical student assistance for 3 month each for year 1 and 2. In kind personnel costs include 3 personnel months of Michael Traugott for the duration of the project.
Travel	Travel cost for running the field trials are applied for in year 1 and 2.
Consumables / Equipment	The implementation of a demonstration network in Austria, necessitates an increase in budget for field-work consumables (15,000 €) and we also ask for an increase in funds for molecular gut content analysis of field-collected weed seed predators (36,000 €) to be sampled in the field experiments and now across the demonstration network.
Subcontracts	A sub-contract of 30k€ is requested for WU (Partner 5). Through this sub-contract, WU will provide the leadership to conduct the meta-analysis (Task 2.1) and will have funds to attend project meetings. It should be noted that the sub-contract will be for leadership and design of Task 2.1 alone. The meta-analysis will be done by the Post-doc requested at INRA.
Other	

TASK(S)

Lead and manage project work in Austria
Conduct field experiment in Austria
Provide molecular analyses for field-collected regurgitates of weed seed predators
Conduct assessment of farmers' perception of weed seed predation ecosystem services in Austria
Co-develop practical strategies for implementation of IPM measures for Austrian framers and agricultural extension workers
Participate in analysis, interpretation and publication of project findings

LITERATURE REFERENCES

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PlosOne (11(2)), e0148781 (2016)
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Advances in Ecological Research (49), 177-224 (2013)
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Plant diversity affects behaviour of generalist root herbivores, reduces crop damage and enhances crop yield.
Ecological Applications (23), 1135-1145 (2013)
- Schallhart N., Tusch M.J., Wallinger C., Staudacher K. & Traugott M.
Effects of plant identity and diversity on the dietary choice of a soil-living insect herbivore.
Ecology (93), 2650-2657 (2012)

ADDITIONAL FIELDS

Organisation acronym	UIBK
Funding agency	BMLFUW

Partner 3: Swedish University of Agricultural Sciences

FINANCE COMMENTS

Personnel	We apply for funds to cover 2 years salary for a postdoctoral researcher, and 3 months of salary for the leader of the SLU team Mattias Jonsson. In-kind includes another 3 months of salary for M Jonsson.
Travel	No funds applied for. However in kind (8073 €) includes travelling to and from project meeting and conferences.
Consumables / Equipment	We apply for funding to cover field work costs and molecular gut content analysis (approx. 21500 €), and general rent which at Dept of Ecology, SLU is 15.98% of salary costs (approx. 23000 €). In kind includes some further field work related costs (approx. 8000 €) and general rent (approx. 3300 €).
Subcontracts	
Other	

TASK(S)

Lead and manage project work in Sweden
Conduct field experiment in Sweden
Conduct assessment of farmers' perception of weed seed predation ecosystem services in Sweden
Co-develop practical strategies for implementation of IPM measures for Swedish farmers and agricultural extension workers Participate in analysis, interpretation and publication of project findings

LITERATURE REFERENCES

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Ecological intensification: harnessing ecosystem services for food security
Trends in Ecology and Evolution (28), 230-238 (2016)
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ADDITIONAL FIELDS

Organisation acronym	SLU
Funding agency	FORMAS

Partner 4: Crop Research Institute

FINANCE COMMENTS

Personnel	The requested funds will be spent for partial cover of the salary of the research team (4 researchers and 1 technician), according to the current regulations at national and institutional level and including social security charges and other statutory costs: Pavel Saska 9 months (coordination, carabid identification, data analysis), Jiří Skuhrovec 9 months (field work), Jan Lukáš 3 months (field work), Milan Řezáč 6 months (field work), Jana Kohoutová 12 months (technical support) over the course of the project.
Travel	The requested travel expenses include attendance of the CZ group leader on the annual consortium meeting, and travel costs to the experimental fields (10 fields across the country) by car of the CRI.
Consumables / Equipment	Consumables include purchasing material necessary for conducting field experiments and sample storage, fuel, scientific literature. A substantial part of the consumables will be spent on MGCA of carabid beetles in the second year of the project.

Subcontracts	Two kinds of subcontracts are planned. In the first and second year of the project we reimburse the costs for the field preparation and management on the study fields in the Czech Republic (10 farms). In the last year of the project we plan to cover the costs of the publication for farmers on the significance of seed predators for weed regulation.
Other	Amortization of equipment used during the project, postage and other telecommunication services will be included.

TASK(S)

Lead and manage project work in Czech Republic
Conduct field experiment in Czech Republic
Develop practical strategies for implementation of IPM measures for Czech farmers and agricultural extension workers
Participate in analysis, interpretation and publication of project findings

LITERATURE REFERENCES

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ADDITIONAL FIELDS

Organisation acronym	CRI
Funding agency	MZE

Partner 5: Wageningen University

FINANCE COMMENTS

Personnel	As part of a sub-contract to UIBK Austria, to provide the leadership necessary for Task 2.1, WU requests funding for a senior researcher to direct the meta-analysis to be done as part of WP2. The leading researcher will be Wopke van der Werf (an agro-ecological statistician), who will have an input level of 24k€ (~ 80 hours per person, per annum of the project). Wopke will not do the meta-analysis himself, but will provide the leadership and supervision necessary for the Post-doc at INRA to conduct the meta-analysis.
Travel	To participate in the project meetings, appropriate conferences and to supervise the Post-doc at INRA, 6 k€ for international travel for the duration of the project, i.e. 2 k€ per year.
Consumables / Equipment	
Subcontracts	
Other	

TASK(S)

Lead and manage project work in The Netherlands
Direction and supervision of Task 2.1 of a meta-analysis of data collected in the consortium and extracted from literature

LITERATURE REFERENCES

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Plain
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Spatially optimal habitat management for enhancing natural control of an invasive agricultural pest: soybean aphid
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Increasing Corn for Biofuel Production Reduces Biocontrol Services in Agricultural Landscapes
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ADDITIONAL FIELDS

Organisation acronym	WU
Funding agency	NWO

ABSTRACT

The goal of C-IPM is to ensure a higher level of implementation of Integrated Pest Management among European farmers. By reanalysing existing data and conducting targeted experiments, BioAWARE will test whether a high richness and abundance of species or functional groups (biodiversity) of weed seed predators assures natural weed control, in the long term, by increasing regulation rates and rendering them resilient to the variation in environmental conditions in EU agriculture. We will then examine both how the weed seed predator diversity can be managed using a combination of in-field and landscape managements, to assure weed seed control, and that can be used to replace or reduce the applications of herbicides as part of weed IPM. To meet the pressing need for farmer-acceptable weed IPM, which they could adopt, we will evaluate the attitudes of farmers (ecological, social and economic) towards natural weed regulation, assured by weed seed predator diversity, relative to herbicide-based weed control. Through co-development by farmers, agronomists and scientists, practical weed IPM solutions will then be developed, demonstrated and evaluated. The ecological, social and economic knowledge we gain for how farmer perceptions change with the resilience of natural regulation, will detail the training, know-how and economic support required to deliver farmer-acceptable IPM that balances natural (biodiversity-derived) and chemical weed control sustainably across the EU.

BACKGROUND

Herbicides are still the predominant means of weed control in conventional EU agriculture, accounting for 42.3% of all pesticides in 2010 [A]. Although primarily to kill weeds, herbicides have marked environmental impact through being toxic to beneficial organisms [B] and impacting human health. EU-wide there are national programs to significantly reduce herbicide input as part of IPM programs, by better using biological control agents that regulate weeds. There is now considerable evidence that weed regulation, due to the activity of seed predators, works in practice [C]. Invertebrates can remove between 20 and 80% of weed seeds on the soil surface [D] and studies at national scales have demonstrated that changes in weed populations, over the course of time, show regulation [E]. The more seed predators observed, the greater the seed predation and the greater the regulation of weeds (Figure 1). Our expectation is that the strength and resilience of this regulation effect is driven the ecological *Insurance Hypothesis* [F]. Each weed predator species, whether vertebrate or invertebrate, contributes to the overall regulation of the weeds. In situations of high predator biodiversity, weed regulation is much more resilient to changes in conditions due to the differing environmental requirements and tolerances of each predator; there is always at least one predator species able to perform weed regulation. Thus, we hypothesise that supporting the diversity of weed seed predators, through appropriate in-field and landscape management, will deliver higher and more resilient weed seed predation resulting in practically relevant levels regulation that could be used to reduce herbicide inputs as part of weed IPM.

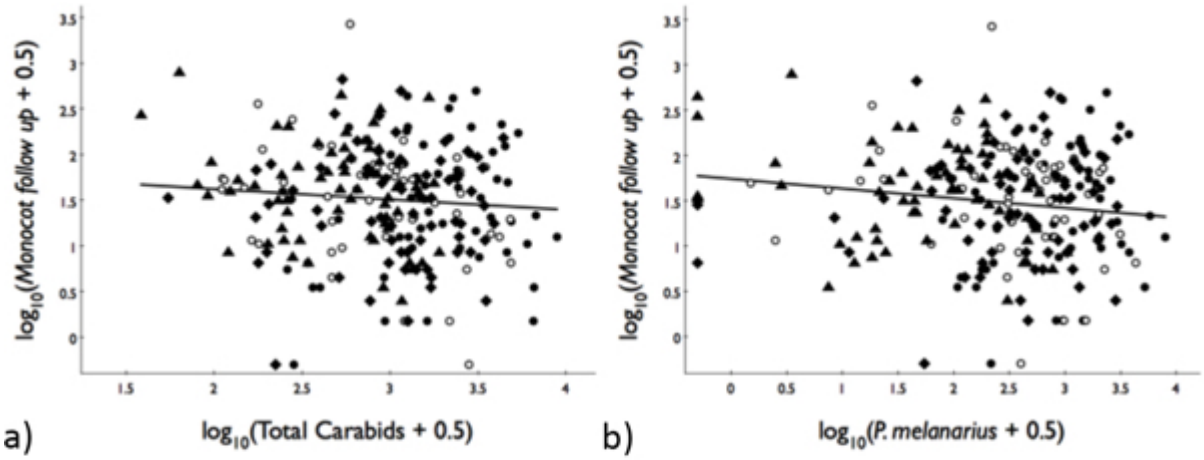

Figure 1. Multiple linear regression models for the seedbank change (as normalized $\log_{10}$(follow-up + 0.5)) against carabid abundance (as $\log_{10}$(pitfall count + 0.5)) in spring-sown beet, spring maize, spring oilseed rape and winter oilseed rape for: a) the monocotyledon seedbank against total carabids; and, b) the monocotyledon follow-up against the omnivorous carabid, *Pterostichus melanarius*.

Bohan et al. (2011) *Journal of Applied Ecology*, 48, 888-898.

To support high weed seed predator diversity, it will be necessary to consider changes in both the in-field and the landscape scale management practices used by farmers. In-field pesticide management, in particular can have direct impacts on predation by generalist predators [G], and cause indirect changes in agricultural community composition that affect the biodiversity of predators [H]. Landscape complexity alone and in interaction with in-field management can affect predator communities and the regulations that they provide [I,J]. There is a need to identify and promote those management options that can support high weed predator diversity for resilient weed seed regulation and that are acceptable to farmers.

Farmer awareness and approval of ecological manipulations in the cropping practices is a cornerstone of adoption and uptake of IPM. Farmers may accept or reject IPM practices for many reasons and apparently useful research is not guaranteed to be adopted. To understand this process of adoption and to develop farmer-acceptable weed IPM based upon seed predators, BioAWARE uses a transdisciplinary approach that involves multiple-actors (stakeholders) across four research workpackages (Figure 2). We would note that while the aim is to consider all weed seed predator groups, where data are available, we limit any trophic assessments of seed predation to invertebrate groups and in particular carabid beetles. In WP1, we will test the insurance hypothesis for whether the diversity of weed seed predators supports seed regulation and regulation resilience at the broader European-wide scale. In WP2, we then: i) determine how this insurance effect co-varies with in-field and landscape management in order to identify management options that deliver high weed seed predator diversity; and, ii) examine whether weed seed predation could be used to reduce or replace herbicides as part of IPM. The new information on the insurance hypothesis, predator diversity management and reduction in herbicide use, will be fed into WP3 (co-run with

an SME Solagro) which seeks to understand the socio-economics of farmer choices for IPM in order to identify the limits to adoption of novel bio-control practices; specifically, given our example of weed seed regulation, what makes a bio-control approach acceptable? Finally, the outputs from WP1-WP3 feed into WP4 (co-run with an SME Solagro) which co-produces with farmers a demonstration to show that ecological manipulations to increase weed seed predator diversity can be used as management in practical, farmer acceptable IPM. This bottom-up, co-production (co-innovation) initiative will foster the robust and agronomically relevant levels of weed control by natural enemies that will promote adoption of weed IPM.

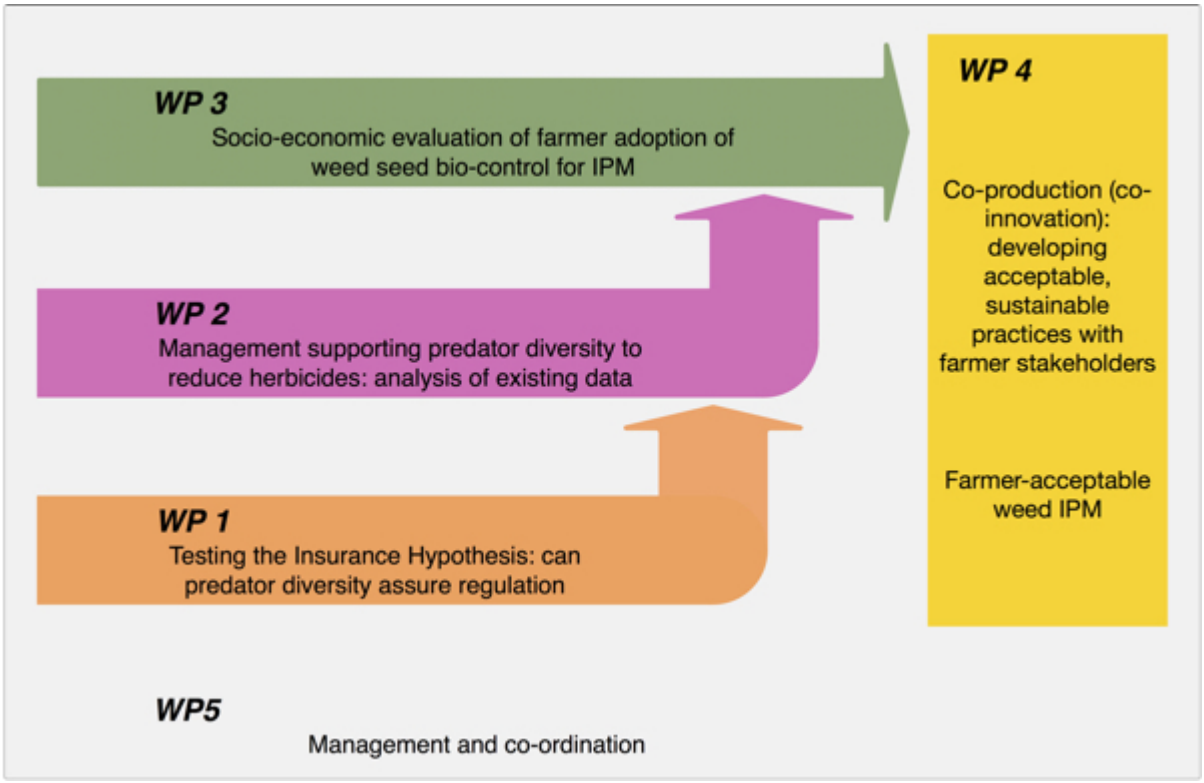

Figure 2. Schematic diagram of the relationship between the workpackages in BioAWARE.

Added value of the consortium

Food production is the largest industrial sector in Europe. The EU strategic vision is to support green growth by combining economic growth, natural resource preservation and efficient resource utilization in well-integrated value chains to build a bio-based economy. In European policy, this sustainable-intensification strategy recognizes the need for space for change, by testing and implementing novel strategic concepts based on new bio-physical and socio-economic research. The vision of the C-IPM call is to provide the applied bio-physical and socio-economic research to deliver a higher level of implementation of IPM among European farmers. BioAWARE will empirically assess how seed predator diversity and abundance affects the levels of in-field weed seed regulation and evaluate the socio-economics of farmer attitudes to biodiversity-derived, weed seed predation across Europe. This will be an important contribution to the goal of delivering acceptable and future-proof IPM solutions that support farmers by better prediction of resilient natural weed regulation and mitigation of chemical weed control for a sustainable, bio-based EU economy.

Main results for the sector

The BioAWARE project is to conduct targeted experiments and to synthesize new results through reanalysis of previous studies (both published and unpublished) to: i) test whether invertebrate weed seed predator biodiversity assures weed regulation ecosystem services and could reduce herbicide applications; ii) understand the limits of acceptability of this biodiversity-derived ecosystem service; and, iii) develop and demonstrate validated and practical landscape and in-field managements (IPM) for farmers to support weed seed predator biodiversity, resilient weed regulation and lower herbicide inputs. Specifically, we will:

· Test the insurance hypothesis for seed predation: that a high biodiversity of weed seed predators will assure natural weed regulation in

agriculture;

· Reconstruct food webs for weed predator and weed species, using molecular approaches;

· Estimate the effects of in-field and landscape management on the biodiversity of predators;

· Predict the conditions under which weed regulation can reduce the need for herbicides in agriculture as part of an IPM approach;

· Examine farmer perceptions with respect to the adoption of IPM measures, supported by weed predator biodiversity, over intensive herbicide use;

· Demonstrate our new understanding of natural weed regulation, chemical control and farmer-acceptable IPM weed solutions.

Innovative output

· Support for farmers by demonstrating the possibilities for better natural weed regulation and mitigation of chemical weed control, through acceptable and future-proof IPM solutions developed in a co-innovation initiative with farmers that bridges the gap between research and adoption.

References (http, doi or ISBN)

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L. ISBN 0 521 78275 9

M. 10.1016/j.ecolecon.2010.04.011

N. 10.1111/1477-9552.12160

WORK PLAN AND WORK PACKAGES

WP1: Can seed predator diversity assure high and resilient weed seed regulation?

WP leader: UIBK (PM: 23), **partners:** INRA (38.5), SLU (12), CRI (22)

Duration: M 1 - 32

Objectives:

O1.1: To test whether seed predator diversity assures weed seed regulation (*Insurance Hypothesis*).

O1.2: To examine how seed predator food web structure and diversity is mechanistically related to weed seed regulation and resilience.

Description of work:

We will conduct a replicated field experiment, repeated in all countries. For each repeat, 12 winter wheat fields will be selected along a gradient of landscape complexity to give a range of seed predator diversities. These fields will be split into two half fields. One half will receive a conventional herbicide treatment and the other half a reduced herbicide level. In each half field we will place out 40 cards with seeds of *Poa annua* to assess seed predation at 4 sampling points along five transects running into the field. Cards will either be placed in cages that exclude vertebrate seed predators ($n = 20$) or uncaged to allow access by both vertebrates and invertebrates (*20*), for one week during two sampling periods in May/June and July. At each sample point we will assess the predator community, weed seed predation and availability of alternative prey using a combination of suction sampling, pitfall trapping and seed rain trapping methods. Regulation of the weed seedbank will be assessed using soil sampling prior to and after the experiment, allowing the evaluation of seedbank change. Germination and identification of the seeds in the soil samples will be done at INRA. In a subset of repeats (Austria, France, Czech Republic and Sweden), food webs will be reconstructed from molecular gut content analysis data of invertebrate carabid seed predators.

Task 1.1 (**UIBK**, INRA, SLU, CRI): Field experimentation.

The field experiment repeats will be managed by workers in each partner country. The seedbank germination work will be coordinated and done by INRA.

Duration: M 1-20

Task 1.2 (**SLU**, INRA, UIBK, CRI): Can seed predator diversity assure high weed seed regulation?

The relationships between seed predation and seed predator species and functional diversity will be analysed using generalized linear mixed models. The statistical goals will be to: i) disentangle vertebrate predation rates from those of invertebrate seed predators and evaluate their contribution; ii) to determine which component of invertebrate diversity (abundance, richness or functional richness) explains the greatest variation in seed predation rates; and, iii) to test whether the identified seed predator diversity metric can explain systematically the change (regulation) of the weed seedbank across the season (O1.1).

Duration: M 1-20

Task 1.3 (**UIBK**, INRA, SLU, CRI): Is food web structure and diversity mechanistically related to weed seed regulation and resilience?

We will reconstruct the food web of trophic interactions between carabid seed predators and different weed species using molecular gut content analysis in Austria, France, Czech Republic and Sweden. For each sampling period, 50 predator individuals from each half field will be tested for the presence/absence of plant DNA, using Next Generation Sequencing of the spectrum of plant species that carabids are exposed to in-field (including the *P. annua* from the seed cards). The 80 replicate, food webs will then be analysed using standard network

metrics. Qualitative (unweighted) and quantitative (weighted) analyses will be conducted using sample meta-data (carabid and weed abundances and measures of seedbank change for each plant species) to examine the robustness of regulation to network structure (as one metric of resilience). We will also use a redundancy analysis, which analyses the diversity of linkage between weed seeds and their predators (a measure of risk of predation) as a second form of resilience analysis [K]. This will be done for species- and functionally-based food webs to achieve O1.2.

Duration: M 18-24

Milestones:

M1.1: Field work completed (M 20)

M1.3: Statistical analysis of the Insurance Hypothesis completed (M 24)

M1.2: Molecular and food web analysis completed (M 28)

Deliverables:

D1.1: Final report on O1.1 and O1.2 for the effects of predator diversity and food web structure on weed seed predation and regulation (M 32)

D1.2: Stakeholder report, produced with WP2, on the practices that increase seed predator diversity, for resilient seed regulation and reduced herbicide use (M 32).

WP2: Landscape and in-field management to support seed predator diversity and reduce herbicide use: existing data

WP leader: SLU (PM: 15), **partners:** WU: (2), INRA (20), UIBK (5), CRI (14)

Duration: M 2-32

Objectives:

O2.1: To evaluate the relationship between landscape and in-field management and seed predator diversity.

O2.2: To assess how weed seed predation and herbicide application co-vary with weed seedbank regulation, and thus whether seed predator diversity might be used to replace (reduce) some applications of herbicide.

Description of work:

In WP2 we will develop a predictive understanding of the in-field and landscape management options that support predator biodiversity and stable seed predation in the long term and whether such seed predation might be used to replace, and thus reduce, some herbicide applications. The first step is to conduct a meta-analysis of the literature to assess how predator biodiversity is maintained with different types of landscape and in-field management as a complement to the results of WP1. A preliminary examination of the literature has revealed close to 1000 articles noting some combination of search-terms for landscape, management and seed predation, and these will form the core database for the meta-analysis. This analysis will consider seed predator species presence/absence, abundance and richness, and functional richness as measures of predator diversity.

The next step will be to conduct a linear modelling analysis (generalized linear and mixed models) for the relationships between herbicide use, seed predation and weed seedbank regulation. The modelling will use existing data available to the consortium (Table 1) to build predictive models for changes in seedbank regulation with herbicide and predator diversity that can then be tested on the experimental data gathered in WP1. This combination of model building and testing, using independent data-sets will assure a valid test of

the expectation that seed predation can replace (reduce) herbicide applications Europe-wide.

Table 1. Overview of existing, detailed data-sets available to the consortium on weed seed predation. In all cases, in-field management meta-data accompany the datasets and landscape data either exist or can be sourced from Corine Land Cover databases.

		Existing data for analysis					
Variable	*Attribute*	*Austria*	*Czech Rep.*	*France*	*Netherlands*	*Sweden*	*UK*
Predators	Abundance	✔	✔	✔	✔	✔	✔
Predation	Seed cards		✔	✔			
Weeds	Cover	✔	✔	✔	✔		✔
	Abundance	✔	✔	✔	✔		✔
	Biomass			✔	✔		✔
	Seedbank						✔
Alternative prey	Abundance		✔			✔	✔
Molecular		✔		✔		✔	✔

Task 2.1 (**WU,** INRA, SLU, CRI): Evaluating the relationship between landscape and in-field management and seed predator diversity.

A meta-analysis, of data in the literature, will be conducted to examine how predator species presence/absence, abundance and richness, and functional richness (predator diversity) are maintained by landscape composition and within-field management (O2.1). The expertise to design the meta-analysis will be brought by WU, through a sub-contract to UIBK, while the analysis itself will be conducted by a Post-doc at INRA. Where possible we will also extend these analyses to effects on seed predation.

Duration: M 2-24

Task 2.2 (**SLU,** UIBK, INRA, CRI): Can seed predator diversity be used to replace (reduce) applications of herbicide?

Existing data in Table 1, will be analysed to test the relationship between metrics of weed seed predation and regulation, and seed predator diversity. Herbicide management, in the form of the Treatment Frequency Index (TFI), will be treated as a co-variate in the analysis alongside other in-field management variables and landscape as appropriate. Our aim is to establish whether there is an interaction effect, between predator diversity and TFI, on seed predation. This would suggest a trade-off in these two methods of weed seed control, which would then be tested on the experimental, herbicide-manipulation data acquired in the experiment conducted in WP1. Validating such an interaction effect will determine whether seed predator diversity might be employed to reduce herbicide inputs (O2.2). We would note that preliminary analysis of the UK national dataset in Table 1 shows a trade-off between seed predator abundance and the number of herbicide applications.

Duration: M 18-32

These results of Task 2.1 and 2.2 will be delivered to WP3 and 4, first in preliminary and then final form, during the project.

Milestones:

M2.1: Completion of the meta-analysis (M 24)

M2.2: Redundancy analysis completed (M 32)

Deliverables:

D2.1: Report on meta-analysis evaluating the relationship between landscape and in-field management and seed predator diversity (M 28)

D2.2: Report on whether herbicides might be replace by management to support seed predator communities (M 32)

D1.2: Stakeholder report, jointly produced with WP2, on the practices necessary to increase seed predator diversity, for resilient seed regulation that can reduce herbicide use (M 32).

WP3 Socio-economic evaluation of farmer adoption of bio-control for IPM

WP leader: INRA (PM: 40), **partners:** UIBK (8)

Duration: 2-36

Objectives:

O3.1: To determine, quantify and order the factors that influence stakeholder (farmer) pest management decisions, and thus better understand the limits of adoption of bio-control for IPM.

Description of work:

Many drivers influence stakeholder decisions to adopt new practices, such as IPM. These include: expected impacts of the practice on their profit or gross margin; behaviour towards risk, such as risks of yield loss / higher yield variability; administrative costs and transition costs of a change in practices; impacts on their health and the environment; training and technical knowledge for IPM; and the availability of subsidies. We will explore the factors that dominate this decision-making, using a discrete choice experiment (DCE) method in France, Sweden and Austria. The DCE method is frequently used for non-market valuation in environmental economics and is particularly well suited to evaluating stakeholder preferences for different alternative choices that have multiple attributes [L,M], and has been applied to biological control [N].

We will present, in the form of a repeated survey conducted during workshops or by mail, several sets of choices to stakeholders for which they make fictional choices. Each set is composed of three options: two cases of a change in weed IPM practices and a third that represents the *status quo* situation of conventional weed management with herbicides. The construction of the choice sets for changed IPM will come from the preliminary results and outputs of O1.1-O2.2 for the role of predator diversity and the managements necessary to support it. For each choice set, the stakeholders will be asked to pick their preferred option. Up to 9 choices will be given to each respondent, in different combinations each time the survey is conducted. The data of stakeholder choices and preferences is then analysed using econometric models, yielding a quantitative value for each decision.

Task 3.1 (**INRA,** UIBK): Discrete Choice Experiments to evaluate factors that influence stakeholder IPM adoption

The DCE will be trialled in France, using stakeholders from the farmer networks of Solagro and EcoPhyto in order to recruit enough respondents at a national scale. Then, repeat DCEs will be done in Austria and Sweden, using available farmer networks, with the survey questionnaire being adapted to the situation in each country. The surveys will be conducted by Master-level socio-economics students, managed by INRA, who will be recruited for periods of six months to implement the surveys in each country.

Duration: M 6-32

Milestones

M3.1: Completion of the DCEs in France, Austria and Sweden (M 32).

Deliverables:

D3.1: Experimental design and Questionnaire (M 12).

D3.2: Working paper presenting the DCE problem, the method, the main results and their interpretation and discussion (M 32).

D3.3: List of recommendations for farmer-acceptable IPM strategies given the results of the DCEs (M 32).

WP4: Co-production (co-innovation): developing acceptable, sustainable practices with farmer stakeholders

WP leader: INRA (32) **partners**: UIBK (6)

Duration: M 1-36

Objectives

O4.1: To determine the effect of ecological intensification measures co-proposed by farmers and researchers on seed predator biodiversity and weed seed regulation.

O4.2: To determine whether farmers consider seed predation a significant element of an integrated weed management strategy and how this perception could evolve.

Description of the work

WP4 will place weed seed predation options within the context of practical farming. The work will take place within the network of farmers available in Austria, and through those of Solagro and EcoPhyto in France, previously used in WP3. With each group of farmers, we will map out the potential methods that may be used to increase and to make resilient the removal of weed seeds by predators, and how these may best be integrated with other crop and weed management practices. Scientific information to support weed seed predation and resilience will come from WP1 and WP2, in the form of preliminary findings for O1.1-2.3, and farmers will also provide their knowledge practices that could augment seed predation and facilitate weed IPM. In addition to the methods of WP1 and WP2, we will also consider the use of cover crops, intercropping, grass and/or flower strips, organic amendments, false seedbeds, types and timing of soil tillage. In a process of co-production, that will also include information from WP3 about stakeholder preferences and cost, we will rank these possible methods and design experimental manipulations at field and/or farm level to demonstrate whether co-proposed interventions for favouring seed predation work as expected.

For the evaluation of effect and impact, in the co-produced demonstrations, farmers will be stratified according to their production orientation (organic vs conventional) and farming scale (large vs small). We will measure effects using the ecological protocols used in WP1, over two years where possible, to evaluate seed predation and the predator species. Sociological methods will be used to evaluate farmer satisfaction, as a measure of acceptability, and how this evolves over the course of the experiment with increasing experience of IPM. We believe that it will be possible to assemble a sample group of ‘replicate’ farmers with sufficient power for a statistical analysis.

Task 4.1 (**INRA**, UIBK): Exploring options for increasing seed predator biodiversity and weed seed regulation with farmers

We will organize workshops of approximately 20 farmers, in both France and Austria to discuss current weed problems and weed management, using both herbicides and naturally occurring predators. This discussion will examine the existing and potential contribution of weed seed predation to overall weed management, using information from WP1-WP3, and the acceptability of competing interventions to increase the contribution of weed seed predation. The workshops should result in both a ranking of acceptable options for increasing weed seed predation and an experimental design to demonstrate the effect and impact of these measures on-farm (O4.1).

Duration: M 1-6

Task 4.2 (**INRA**, UIBK): Co-produced field experiments to demonstrate the effect of selected ecological intensification options for increasing weed seed predator biodiversity and weed seed regulation

We will experimentally test selected designs for increasing weed seed predation over two consecutive field seasons. The first year results will be analysed and discussed with farmer groups. Sociological measurement of their satisfaction will be made and through further co-production the plans for the next season will be 'evolved'. After the second season the results will again be analysed and discussed with farmers. Their satisfaction regarding the various options for increasing rates of seed predation will be evaluated and ranked. With the establishment of this network in Austria, we propose extending the molecular work to the demonstration network in order to demonstrate how such detailed information affects farmer sentiment and acceptability, and request the consumables to do this. This will provide a clear picture of the ecological effect/impact of management for increasing seed predation, within a co-developed IPM framework, and how farmer acceptability evolves (O4.2).

Duration: M 7-32

Milestones

M4.1: Completion of ranking of feasible and acceptable options for increasing weed seed predation and development of an experimental design to demonstrate these effects (M 6).

M4.2: Completion of evaluation of co-developed weed IPM approaches, using seed predation, in France and Austria (M 32)

Deliverables:

D4.1: Experimental design for demonstrating weed predation IPM approaches (M 6).

D4.2: Recommendations for farmer-acceptable IPM strategies, incorporating the findings of D3.3 (M 36)

WP5: Management and co-ordination

WP leader: INRA (PM: 10), **partners**: WU (1), UIBK (3), SLU (3), CRI (3)

Duration: M 1-36

Description of the work

The project will be run by a management committee made up of the project research partners and the sub-contracted organisations, WU and the SME, Solagro. The committee will meet every 6 months of the project at one of the partner sites, to coincide with project scientific meetings. The aim of the management committee is to ensure the smooth running of the project and the delivery of milestones and reports to the project schedule. Given that each of the workpackages will be significant generators and users of data from the other workpackages, the management committee will also assure that there is free access to appropriate data between partners, data quality is maintained and ultimately the outputs of the project are available to both the scientific and wider stakeholder community (see Dissemination).

The management of the science of the project will be done through a scientific committee. This will be a superset of the management committee, including post-doctoral scientists and technicians involved in the research. Scientific meetings will be run every six months of the project, but there will also be scope for more frequent, targeted meetings as required.

Task 5.1 (**INRA**, WU, SLU, CRI, UIBK): Data management strategy

The basic sets of data available to and produced by the project will be parsed into databases. These data, as with all data in the project, will be coded appropriately with mark-up and meta-data tags to be compliant with GEOSS (https://www.earthobservations.org), Global Biodiversity Information Facility (GBIF, http://www.gbif.org), CICES v4.3 (http://www.cices.eu) and Copernicus (http://www.copernicus.eu) standards.

The ecological models will primarily be constructed in *R*, an open-standard statistical package. These models will use and contribute to knowledge hubs, such as the MACSUR hub in FACCE-JPI.

Within the project, and for a period for 2 years after the end of the project, we will use a data-sharing and communication platform to assure that the project partners have access to data and information. Examples of these include phpBB (https://www.phpbb.com), with the advantage that they are robust, quick and free. They also include functions to rapidly 'spin-off' websites for external communication, and can be backed-up at set intervals to allow date-stamping and archiving of project endpoints.

Duration: M 1-36

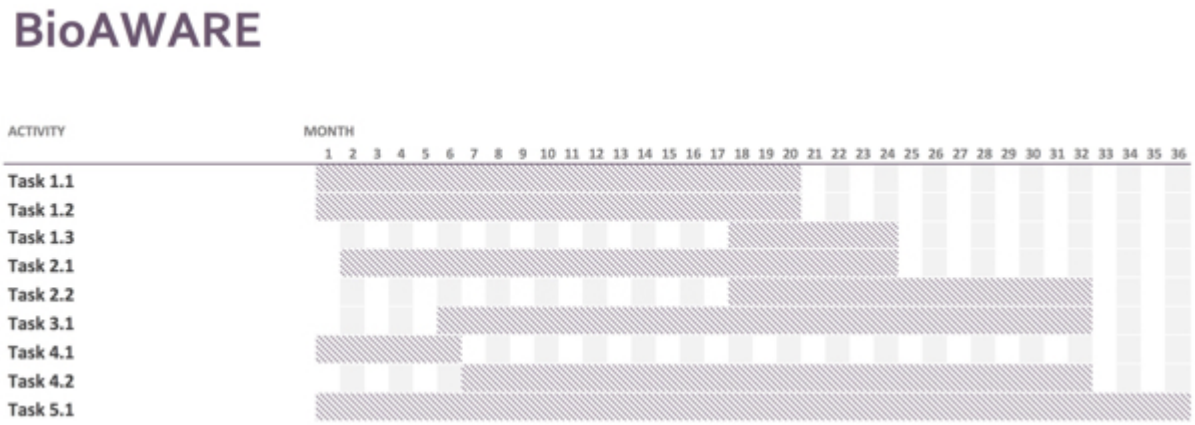

Figure 3. GANTT chart for the temporal relationships between tasks in BioAWARE.

RELATED PROJECTS

Consortium members are involved in at least 10 ongoing national and EU projects of complimentary, but direct, importance to the work in BioAWARE.

Building food webs – weed seed predator interactions

The trophic interactions between predators and their prey are key components of the science in WP1 and WP2, and research being done by consortium members to understand these trophic interactions will feed directly into these WPs. Work within the Czech Science Foundation (*14-02773S*) project is being used to generate a preference list of seeds eaten by invertebrate seed predators. In conjunction with ongoing molecular trophic work in the FWF (Austria) project "*Trophic assessment of ecosystem services provided by carabid beetles in agricultural land*" this will allow us to develop the methods to screen invertebrates (predominantly carabid beetles) for the precise species of weed seed they have eaten using NGS approaches. Work within the FORMAS (Sweden) project *FOODWEBS* will then deliver some of the methods that will then be used to reconstruct predator-weed seed food webs from this molecular data.

Ecological Regulation

Weed seed predation is just one of many naturally occurring ecological regulation functions that occurs in farmland. Consortium members are currently working to understand this wider context within the Biodiversa project *APPEAL* and the FP7 projects *LIBERATION* and *QUESSA*. These projects seek to quantify the effects of a diverse range of regulations across Europe, with particular respect given to in-field and landscape management. Knowledge from these projects will be used to some of the theoretical underpinning necessary for the statements we will make on supporting weed seed predator biodiversity using in-field and landscape management.

Resilience to change

In the FACCE SURPLUS project *PREAR*, the goal is to understand how regulation functions, including pollination and predation, will be affected by climate change. The approach taken is one involving evaluating the resilience of ecological networks, including food webs, to climate change and the network methods developed will be directly applicable to Task 1.3. Empirical evidence of long-term and large scale resilience of seed predation will also come from a French national biomonitoring project of Ecosystem Services *SEBIOPAG*.

Socio-economics and ecosystem services

Ecological functions, such as seed predation, are increasingly being viewed through the prism of Ecosystem Services. Ecosystem Services are strictly the economic and social value that stakeholders place on ecological functions. All the projects, above, as well as the French National projects *ANR PEERLESS* and *ANR AgrioBioSE*, have a core element of evaluating ecological functions in terms of social and economic value that will directly impact the discussions that we have with farmers in WP3/4, and the interpretations we make of the value and acceptability of weed seed predator-based IPM.

DISSEMINATION

The FACCE-JPI Strategic Research Agenda stresses the need to promote interactions between “researchers, farmers, and the farming industry, private sector and consumers, in order to provide new opportunities for innovation”. To this end, BioAWARE will partner with a not-for-profit SME, Solagro (http://www.solagro.org/), to improve communication and technology transfer with farmers and the farming industry.

Solagro have developed, across a network of farmers, demonstrations that have proven to transfer knowledge and technology. Solagro will help us run a series of interactive demonstrations in WP4 to test our ecological and socio-economic research findings and co-develop criteria for the acceptability/adoption of weed seed predation services (e.g. D3.3). This will be wholly novel, bringing together ecological data, farmer practice and farmer sensitivities to cost to understand the limits of acceptability/adoption of weed seed regulation services for the first time. The transfer to stakeholders will be through pamphlets, presentations and articles in the farming press across the EU. Internet and social media will also be used to amplify the dissemination of the information we generate. Solagro specialize in this form of dissemination, and our will be results will be released through Herbea, a collaborative site promoting Conservation Biological Control (http://www.herbea.org/) and the Osaé site for disseminating agroecological practices (http://www.osez-agroecologie.org/).

To foster communication and dissemination amongst scientists BioAWARE will interact with other research infrastructures (ERA-NETs, AnaEE and LIFEWATCH EU e-Infrastructures). Ideas for collaboration may come from the Biodiversa ERA-NET database, identifying projects with which to share best practice. Routes to dissemination also exist through other research project that the consortium are members of, at the EU and national scales.

Finally, we will disseminate results through the scientific literature.

SOCIETAL AND ETHICAL ASPECTS

The goal of C-IPM is to ensure a higher level of implementation of Integrated Pest Management among European farmers. Farmers are, therefore, key targets for the research in BioAWARE. The practicalities of project work with farmers are that each nation state has unique farmer-extension services and the available C-IPM funding varies markedly. Thus, our approach will be to conduct ecological research in all countries of the BioAWARE consortium, but use France, Sweden and Austria in particular as model study-nations for the socio-economic work with farmers.

In France, for example, the DEPHY network (~ 2000 farms) was established as part of the EcoPhyto plan to demonstrate sustainable reductions of pesticide use for improved societal and environmental well-being. BioAWARE will use a part of the DEPHY network, where EcoPhyto deem this appropriate, to examine farmer attitudes to the adoption of IPM. A sub-contract to Solagro (SME), will be used to build farmer questionnaires and conduct workshops. The approach, guided by BioAWARE socio-economists, will use stakeholder-choice experimental approaches. Farmer perceptions will be sought under conditions of information about the effectiveness and value of IPM and then retested under new economic or biodiversity information. This tests how acceptability changes with farmer-learning and economic support, and helps build an understanding of the limits of IPM adoption. The transfer of our research back to farmers will use DEPHY and Solagro in France and comparable routes in each study-nation.

There are no ethical implications of the research in BioAWARE.

FINANCES

Requested funding

Organisation name	Funding agency	Personnel	Travel	Consumables / Equipment	Subcontracts	Requested Funding	Total Own Contribution	Total Costs
INRA	MAAF	219327	12000	35000	20000	297781	217105	514886
Overhead		8774	480	1400	800			
University of Innsbruck	BMLFUW	152650	12000	51000	30000	245650	21876	267526
Overhead								
Swedish University of Agricultural Sciences	FORMAS	145197		44775		252184	48006	300190
Overhead		62212						
Crop Research Institute	MZE	34400	3600	6810	5800	61360	3640	65000
Overhead		7500		3250				
Wageningen University	NWO					0	0	0
Overhead								
TOTAL		630060	28080	142235	56600	856975	290627	1147602

Own contribution

Organisation name	Personnel	Travel	Consumables / Equipment	Subcontracts	Other	Total Own Contribution
INRA	217105					217105
University of Innsbruck					21876	21876
Swedish University of Agricultural Sciences	20020	8073	11302		8611	48006
Crop Research Institute	2000		1200		440	3640
Wageningen University						0
TOTAL	239125	8073	12502	0	30927	290627

DR DAVID A. BOHAN

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1992 BSc (Hons) 2:1 in Applied Biology with Parasitology, Imperial College, London University.

Research:
I am an applied ecologist with research interests in ecological functions in agriculture. Specifically, I work with understanding how ecological functions, such as weed seedbank regulation and slug control become ecosystem services. As a model system I use the carabid beetles and study these at the laboratory (behaviour and microcosm), mescosom, field and landscape scale, to build ecological networks. I am currently developing approaches to utilise ecological, social and economic networks to better understand how ecological functions become ecosystem services.

Recent publications:
80 published papers: h index of 27.

1. Bohan, D.A. & Haughton, A.J. (2012) Effects of local landscape richness on in-field weed metrics across the Great Britain scale. *Agriculture, Ecosystems and Environment*, **158**, 208–215.
2. Bohan, D.A., Bonte, D., Ma, A., Macfadyen, S., Martinet, V., McInerny, G.J., Montoya, J.M., Mulder, C., Pascual, U., Pocock, M.J.O., White, P., et al. (2016) Networking Our Way to Better Ecosystem Service Provision. *Trends in Ecology & Evolution*, **31**, 112–121.
3. Bohan, D.A., Boursault, A., Brooks, D.R. & Petit, S. (2011) National-scale regulation of the weed seedbank by carabid predators. *Journal of Applied Ecology*, **48**, 888–898.
4. Bohan, D.A., Caron-Lormier, G., Muggleton, S., Raybould, A. & Tamaddoni-Nezhad, A. (2011) Automated discovery of food webs from ecological data using logic-based machine learning. *PLoS One*, **6**, e29028.
5. Bohan, D.A., Powers, S.J., Champion, G.T., Haughton, A.J., Hawes, C., Squire, G.R., Cussans, J. & Mertens, S.K. (2011) Modelling rotations: can crop sequences explain arable weed seedbank abundance? *Weed Research*, **51**, 422–432.
6. Bohan, D.A., Raybould, A., Mulder, C., Woodward, G., Tamaddoni-Nezhad, A., Bluthgen, N., Pocock, M.J.O., Muggleton, S., Evans, D.M., Astegiano, J., Massol, F., Loeuille, N., Petit, S. & Macfadyen, S. (2013) Networking Agroecology: Integrating the Diversity of Agroecosystem Interactions. *Advances in Ecological Research*, **49**, 1–67.
7. Bond, A.J., Dockerty, T., Lovett, A.A., Riche, A.B., Haughton, A.J., Bohan, D.A., Sage, R.B., Shield, I.F., Finch, J.W., Turner, M.M. & Karp, A. (2011) Learning How to Deal with Values, Frames and Governance in Sustainability Appraisal. *Regional Studies*, **45**, 1157–1170.
8. Caron-Lormier, G., Bohan, D.A., Dye, R., Hawes, C., Humphry, R.W. & Raybould, A. (2011) Modelling an ecosystem: The example of agro-ecosystems. *Ecological Modelling*, **222**, 1163–1173.
9. Davey, J.S., Vaughan, I.P., Andrew King, R., Bell, J.R., Bohan, D.A., Bruford, M.W., Holland, J.M. & Symondson, W.O.C. (2012) Intraguild predation in winter wheat: prey choice by a common epigeal carabid consuming spiders. *Journal of Applied Ecology*, **50**, 271–279.
10. Haughton, A.J., Bohan, D.A., Clark, S.J., Mallott, M.D., Mallott, V., Sage, R. & Karp, A. (in press) Dedicated biomass crops can enhance biodiversity in the arable landscape. *GCB Bioenergy*, 10.1111/gcbb.12312.
11. King, R.A., Moreno-Ripoll, R., Agusti, N., Shayler, S.P., Bell, J.R., Bohan, D.A. & Symondson, W.O.C. (2011) Multiplex reactions for the molecular detection of predation on pest and nonpest invertebrates in agroecosystems. *Molecular Ecology Resources*, **11**, 370–373.

12. Labruyere, S., Bohan, D.A., Biju-Duval, L., Ricci, B. & Petit, S. (2015) Local, neighbor and landscape effects on the abundance of weed seed-eating carabids in arable fields: A nationwide analysis. *Basic and Applied Ecology*.
13. Mulder, C., Ahrestani, F.S., Bahn, M., Bohan, D.A., et al. (2013) Connecting the Green and Brown Worlds: Allometric and Stoichiometric Predictability of Above- and Below-Ground Networks. *Advances in Ecological Research*, **49**, 69–175.
14. Mulder, C., Bennett, E.M., Bohan, D.A., et al. (2015) 10 Years Later: Revisiting Priorities for Science and Society a Decade After the Millennium Ecosystem Assessment. *Advances in Ecological Research*, **53**, 1–53.
15. Pocock, M.J.O., Evans, D.M., Fontaine, C., Harvey, M., Julliard, R., McLaughlin, Ó., Silvertown, J., Tamaddoni-Nezhad, A., White, P.C.L. & Bohan, D.A. (2016) The Visualisation of Ecological Networks, and Their Use as a Tool for Engagement, Advocacy and Management. *Advances in Ecological Research*, **54**, 41–85.
16. Poggio, S.L., Macfadyen, S. & Bohan, D.A. (2015) Reconciling Techno-simplicity and Eco-complexity for future food security. *F1000Research*.
17. Reynolds, A.M., Leprêtre, L. & Bohan, D.A. (2013) Movement patterns of Tenebrio beetles demonstrate empirically that correlated-random-walks have similitude with a Lévy walk. *Scientific Reports*, **3**, 3158.
18. Ricci, B., Franck, P., Valantin-Morison, M., Bohan, D.A. & Lavigne, C. (2013) Do species population parameters and landscape characteristics affect the relationship between local population abundance and surrounding habitat amount? *Ecological Complexity*, **15**, 62–70.
19. Stewart, R.I.A., Dossena, M., Bohan, D.A., Jeppesen, E., Kordas, R.L., Ledger, M.E., Meerhoff, M., Moss, B., Mulder, C., Shurin, J.B., Suttle, B., Thompson, R., Trimmer, M. & Woodward, G. (2013) Mesocosm Experiments as a Tool for Ecological Climate-Change Research. *Advances in Ecological Research*, **48**, 71–181.
20. Tamaddoni-Nezhad, A., Afroozi Milani, G., Raybould, A., Muggleton, S. & Bohan, D.A. (2013) Construction and Validation of Food Webs Using Logic-Based Machine Learning and Text Mining. *Advances in Ecological Research*, **49**, 225–289.
21. Vacher, C., Tamaddoni-Nezhad, A., Kamenova, S., Peyrard, N., Moalic, Y., Sabbadin, R., Schwaller, L., Chiquet, J., Alex Smith, M., Vallance, J., Fievet, V., Jakuschkin, B. & Bohan, D.A. (2016) Learning Ecological Networks from Next-Generation Sequencing Data. *Advances in Ecological Research*, **54**, 1–39.
22. White, M.T., Lwetoijera, D., Marshall, J., Caron-Lormier, G., Bohan, D.A., Denholm, I. & Devine, G.J. (2014) Negative Cross Resistance Mediated by Co-Treated Bed Nets: A Potential Means of Restoring Pyrethroid-Susceptibility to Malaria Vectors. *PloS one*, **9**, e95640.

Selected recent research grants:

Leader FACCE JPI SURPLUS « PREAR » 2016-2019 http://faccesurplus.org/research-projects/prear/

Agreenskills Fellowship (405) for Monica Fernandez-Aparicio Ruiz « Understanding the functional basis of ecosystem service delivery by cover crops » 2014-2016

FEDER PARI AGREE (Région Bourgogne Franche-Comté) « Interactions Biotiques » Post-doctoral scientist 2015-2017

Workpackage Leader (WP3) ANR PEERLESS 2013-2017 **ANR-12-AGRO-0006**

Workpackage Leader (WP3) ANR AgroBioSE 2014-2017 **ANR-13-AGRO-0001**

Working group CESAB COREIDS 2015-2018

Project ADOSE-CAPP (INRA ECOSERV) 2016-2019

Project LEARN-BIOCONTROL (INRA SPE) 2016-2019

Other roles and responsabilities:

Editor of *Advances in Ecological Research*. Expert 'Recovery' working group of European Standard Characteristics of Non-Target Arthropod Regulatory Testing (ESCORT 3). Steering Group member for the EFSA project, « Establishing a database of bio-ecological information on non-target arthropod species to support the environmental risk assessment of genetically modified organisms in the EU ».Expert Panel of EFESE Agriculture, the French national evaluation of ecosystem services.

ACADEMIC CURRICULUM VITAE MICHAEL TRAUGOTT

Personal data

Date and place of birth: 06/09/1970, Wels (Austria)
Nationality: Austria
Marital status: Married, two children
Languages: German (native), English (fluent)
ORCID.ID: 0000-0001-9719-5059
Webpage: www.uibk.ac.at/ecology/staff/persons/traugott.html.en

University education

06/12/2007:	**Habilitation** ("professorial qualification") for the Subject Ecology at the University of Innsbruck
13/06/2001:	**Doctor of natural sciences** (University of Innsbruck)
1998 – 2001:	Doctoral studies in Zoology/Ecology
26/11/2001:	2nd **Master of natural sciences** (University of Innsbruck)
1992 – 2001:	Studies in Environmental Sciences & Education Sciences
14/07/1997:	1st **Master of natural sciences** (University of Innsbruck)
1990 – 1997:	Studies in Biology (Zoology, Agroecology)

Research positions

11/2011 – present:	**Associate Professor**, Institute of Ecology, University of Innsbruck
01/2008 – 10/2011	**Senior Researcher with Habilitation** (Associate Professor equivalent), Institute of Ecology, University of Innsbruck
08/2002 – 01/2008	**Assistant Professor**, Institute of Ecology, University of Innsbruck
04/2005 – 09/2006:	**Marie-Curie Fellow** (Individual Intra-European Fellowship), Cardiff School of Biosciences, Cardiff University, Wales, UK
12/1998 – 07/2002:	**Contract Assistant Professor**, Research Institute for Alpine Agriculture and Forestry, University of Innsbruck

Main areas of research

- Molecular trophic ecology
- Biological pest control
- Agroecology & Entomology

Overview on publications and presentations

- 65 papers in international ISI-ranked journals and 10 papers in other peer-reviewed scientific journals
- 28 invited talks and over 180 conference contributions
- 20 publications in popular science journals

Editorships and other scientific community services

Editorial tasks: Editor-in-Chief: *Journal of Pest Science*, Subject Editor: *Bulletin of Entomological Research* (2007-2015); Editorial Board Member: *Journal of Applied Entomology*

Peer-reviewing services: Within past five years reviewing of over 90 manuscripts for 25 ISI-ranked journals and examining 15 project applications for international research organisations.

Congress Organisation: During the past five years I have organized six international conferences and conference sections.

Most important research projects funded in the past five years

1. Trophic assessment of ecosystem services provided by carabid beetles in agricultural land. Austrian Science Fund: PI C. Wallinger, University of Innsbruck, Co-PI: M. Traugott. 2016-2018. 351 k€.
2. eDNA-AlpFisch: Detection and semi-quantitative population assessment of alpine fish species using environmental DNA. Austrian Research Promotion Agency. 2016-2018. 260 k€.
3. Effect of fertilization type on invertebrate food webs and herbivore biocontrol. Austrian Science Fund. 2013-2016. 350 k€.
4. APPEAL: Assessment and valuation of Pest suppression Potential through biological control in European Agricultural Landscapes. BiodivERsA “Pan-European Call for International Research Proposals on Biodiversity and Ecosystem Services”. 2012-2014. Coordinator: Dr.. M. Jonsson, Swedish University of Agricultural Sciences; 759 k€.
5. Assessing the feeding ecology of the Great Cormorant in Alpine foreland freshwaters by molecular and micro-chemical means. Austrian Science Fund. 2012-2014. 346 k€.
6. The importance of natural enemy diversity and food-web structure for biological control at organic and conventional farms. PI: M. Jonsson, Swedish University of Agriculture Sciences, Uppsala; Co-PI: M. Traugott. The Swedish Research Council Formas, 2011-2014, 390 k€.
7. Effect of agricultural intensification on cereal aphid-primary parasitoid-hyperparasitoid food webs. PIs: M. Traugott & I.M.G. Vollhardt, University of Göttingen, Germany. Joint project funded by the German Research Foundation and the Austrian Science Fund within the D-A-CH framework. 2011-2014, 320 k€.

Name and institution of key international cooperation partners in the last 5 years

A. Zitek, T. Prohaska, Univ. of Natural Resources and Applied Life Sciences, Austria

I.M.G. Vollhardt, University of Göttingen, Germany

B. Eitzinger & S. Scheu, University of Göttingen, Germany

M. Jonsson, Swedish University of Agriculture Sciences, Sweden

W.O.C. Symondson, Cardiff University, UK

J.R. Bell, Rothamsted Research, UK

J. Kroschel, International Potato Center, Peru

A. Richter & W. Osborne, University of Canberra, Australia

C. Straub, Ursinus College, USA

Scientific publications of Michael Traugott 2011-2016:

Peer-reviewed papers in journals indexed by ISI Web of Knowledge

1. Tiede J., Wemheuer B., **Traugott M.,** Daniel R., Tscharntke T., Ebeling A. & Scherber C. (2016) Trophic and Non-Trophic Interactions in a Biodiversity Experiment Assessed by Next-Generation Sequencing. ***PlosOne*** 11(2): e0148781.
2. Oehm J., Thalinger B., Mayr H. & **Traugott M.** (2016): Maximising dietary information retrievable from carcasses of Great Cormorants *Phalacrocorax carbo* using a combined morphological and molecular analytical approach. ***Ibis*** 158, 51-60.
3. Thalinger B., Oehm J., Mayr H., Obwexer A., Zeisler C. & **Traugott M.** (2016): Molecular prey identification in Central European piscivores. ***Molecular Ecology Resources*** 16, 123-137.
4. Staudacher K., Jonsson T. & **Traugott M.** (2016): Diagnostic PCR assays to unravel food web interactions in cereal crops with focus on biological control of aphids. ***Journal of Pest Science***. 89, 281-293.
5. Sint D. & **Traugott M.** (2016): Food Web Designer: a flexible tool to visualize interaction networks. ***Journal of Pest Science*** 89, 1-5.
6. Wallinger C., Sint D., Baier F., Schmid C., Mayer R. & **Traugott M.** (2015): Detection of seed DNA in regurgitates of granivorous carabid beetles. ***Bulletin of Entomological Research*** 105, 728-735.
7. Sint D., Thurner I., Kaufmann R. & **Traugott M.** (2015): Sparing spiders: faeces as a non-invasive source of DNA, ***Frontiers in Zoology***. 12(3), DOI 10.1186/s12983-015-0096-y
8. Roubinet E., Straub C.S., Jonsson T., Staudacher K., **Traugott M.,** Ekbom B. & Jonsson M. (2015): Additive effects of predator diversity on pest control caused by few interactions among predator species. ***Ecological Entomology*** 40, 362–371.
9. Kitz F., Steinwandter M., **Traugott M.** & Seeber J. (2015): Increased decomposer diversity accelerates and potentially stabilises litter decomposition. ***Soil Biology & Biochemistry*** 83 138-141.
10. **Traugott M.**, Benefer C.M., Blackshaw R.P., van Herk W.G. & Vernon R.S. (2015): Biology, Ecology and Control of Elaterid Beetles in Agricultural Land. ***Annual Review of Entomology*** 60, 313-334.
11. Sint D., Niederklapfer B., Kaufmann R. & **Traugott M.** (2014): Group-specific multiplex PCR detection systems for the identification of flying insect prey. ***PlosOne*** 9(12): e115501. doi:10. 1371/journal.pone.0115501.
12. Raso L., Sint D., Rief A., Kaufmann R. & **Traugott M**. (2014): Molecular identification of adult and juvenile linyphiid and theridiid spiders in Alpine glacier foreland communities. ***PlosOne*** 9(7): e101755. doi:10.1371/journal.pone.0101755.
13. Raso L., Sint D., Mayer R., Plangg S., Recheis T., Brunner S., Kaufmann R. & **Traugott M**. (2014): Intraguild Predation in Pioneer Predator Communities of Alpine Glacier Forelands. ***Molecular Ecology*** 23, 3744-3754.
14. Wallinger C., Staudacher K., Schallhart N., Mitterrutzner E., Steiner E.-M., Juen A. & **Traugott M.** (2014): How generalist herbivores exploit belowground plant diversity in temperate grasslands. ***Molecular Ecology*** 23, 3826-3837.

15. Eitzinger B., Unger E. M., **Traugott M.** & Scheu S. (2014): Effects of prey quality and predator body size on prey DNA detection success in a centipede predator. ***Molecular Ecology*** 23, 3767-3776.
16. Gomez-Polo P., **Traugott M**., Alomar O., Castañé C., Rojo S. & Agustí N. (2014): Identification of the most common predatory hoverflies of Mediterranean vegetable crops and their parasitism by multiplex PCR. ***Journal of Pest Science*** 87, 371–378.
17. **Traugott M.**, Kamenova S., Ruess L., Seeber J. & Plantegenest M. (2013): Empirically characterising trophic networks: what emerging DNA-based methods, stable isotope and fatty acid analyses can offer. ***Advances in Ecological Research*** 49, 177-224.
18. Staudacher K., Schallhart N., Thalinger B., Wallinger C., Juen A. & **Traugott M.** (2013): Plant diversity affects behaviour of generalist root herbivores, reduces crop damage and enhances crop yield. ***Ecological Applications*** 23, 1135-1145.
19. Balmer O., Pfiffner L., Schied J., Willareth M., Leimgruber A., Luka H. & **Traugott M.** (2013): Non-crop flowering plants restore top-down herbivore control in agricultural fields. ***Ecology and Evolution*** 3, 2634-2646.
20. Waldner T., Sint D., Juen A. & **Traugott M.** (2013): The effect of predator identity on post-feeding prey DNA detection success in soil-dwelling macro-invertebrates. ***Soil Biology & Biochemistry*** 63, 116-123.
21. Staudacher K., Schallhart N., Pitterl P., Wallinger C., Brunner N., Kromp B., Landl M., Glauninger J. & **Traugott M**. (2013): Occurrence of *Agriotes* wireworms in Austrian agricultural land. ***Journal of Pest Science*** 86, 33-39.
22. Eitzinger B., Micic A., Körner M., **Traugott M.** & Scheu S. (2013): Unveiling soil food web links: New PCR assays for detection of prey DNA in the gut of soil arthropod predators. ***Soil Biology & Biochemistry*** 57, 943-945.
23. Wallinger C., Staudacher K., Schallhart N., Peter E., Dresch P., Juen A. & **Traugott M.** (2013): The effect of plant identity and the level of plant decay on molecular gut content analysis in a herbivorous soil insect. ***Molecular Ecology Resources*** 13, 75–83.
24. Schallhart N., Tusch M.J., Wallinger C., Staudacher K. & **Traugott M.** (2012): Effects of plant identity and diversity on the dietary choice of a soil-living insect herbivore. ***Ecology*** 93, 2650-2657.
25. Sint D., Raso L. & **Traugott M.** (2012): Advances in multiplex PCR: balancing primer efficiencies and improving detection success. ***Methods in Ecology and Evolution*** 3, 898–905.
26. Seeber J., Rief A., Richter A., **Traugott M.** & Bahn M. (2012): Drought-induced reduction in uptake of recently photosynthesized carbon by springtails and mites in alpine grassland. ***Soil Biology & Biochemistry*** 55, 37-39.
27. Waldner T. & **Traugott M.** (2012): DNA-based analysis of regurgitates: a non-invasive approach to examine the diet of invertebrate consumers. ***Molecular Ecology Resources*** 12, 669–675.
28. **Traugott M.**, Bell J.R., Raso L., Sint D. & Symondson W.O.C. (2012): Generalist predators disrupt parasitoid aphid control by direct and coincidental intraguild predation. ***Bulletin of Entomological Research*** 102, 239–247.

29. Wallinger C., Juen A., Staudacher K., Schallhart N., Mitterrutzner E., Steiner E.-M., Thalinger B. & **Traugott M**. (2012): Rapid Plant Identification Using Species- and Group-Specific Primers Targeting Chloroplast DNA. ***PlosOne*** 7(1), e29473. doi:10.1371/journal.pone.0029473.

30. von Berg K., **Traugott M.** & Scheu S. (2012): Scavenging and active predation in generalist predators: A mesocosm study employing DNA-based gut content analysis. ***Pedobiologia*** 55, 1-5.

31. Klarica J., Brandstätter A., **Traugott M.** & Juen A. (2012): Comparing four mitochondrial genes in earthworms - implications for identification, phylogenetics, and discovery of cryptic species. ***Soil Biology & Biochemistry*** 45, 23-30.

32. Eitzinger B. & **Traugott M.** (2011): Which prey sustains cold-adapted invertebrate generalist predators in arable land? Examining prey choices by molecular gut content analysis. ***Journal of Applied Ecology*** 48, 591-599.

33. Sint D., Raso L., Kaufmann R. & **Traugott M.** (2011): Optimizing methods for PCR-based analysis of predation. ***Molecular Ecology Resources*** 11, 795-801.

34. Schallhart N., Tusch M.J., Staudacher K., Wallinger C. & **Traugott M.** (2011): Stable isotope analysis reveals whether soil-living elaterid larvae move between agricultural crops. ***Soil Biology & Biochemistry*** 43, 1612-1614.

35. Oehm J., Juen A., Nagiller K., Neuhauser S. & **Traugott M.** (2011): Molecular scatology: how to improve prey DNA detection success in avian faeces? ***Molecular Ecology Resources*** 11, 620–628.

36. Staudacher K., Wallinger C., Schallhart N. & **Traugott M**. (2011): Detecting ingested plant DNA in soil-living insect larvae. ***Soil Biology & Biochemistry*** 43, 346-350.

37. Staudacher K., Pitterl P., Furlan L., Cate P.C. & **Traugott M.** (2011): PCR-based species identification of *Agriotes* larvae. ***Bulletin of Entomological Research*** 101, 201-210.

CV Mattias Jonsson

Current position

Since October 2011	Senior researcher (permanent, approx. 80% research), Dept. of Ecology, SLU, Uppsala

Education and degrees

27 June 2002, PhD in forest entomology, SLU
Title: Dispersal ecology of insects inhabiting wood-decaying fungi
Supervisors: Prof. Göran Nordlander and Assoc. prof. Oskar Kindvall

22 February 1996, M.Sc. (Fil. Mag) in biology, Umeå University

Associate professor (Docent)

8 December 2010, Associate Professor (Docent) in biology with emphasis on ecology, SLU

Previous positions (after dissertation)

October 2009 – September 2011	Researcher, Dept. of Ecology, SLU
September 2006 – August 2009	Post doc, Bio-Protection Research Centre, Lincoln University, New Zealand
August 2005 – August 2006	Post doc, National Centre for Advanced Bio-Protection Technologies, Lincoln University, New Zealand
July 2002 – July 2005	Researcher, Dept of Entomology, SLU

Longer stays abroad

- Research visit at Dept. of Ecology, Zoological Institute, Johannes Gutenberg University, Mainz, Germany, 1998-2000 (in all 8 months)
- Post doc at Bio-protection research Centre, Lincoln University, New Zealand, August 2005 - August 2009 (4 years).
- Guest researcher and teacher at World Agroforestry Centre (ICRAF), Nairobi, and Embu University College, Embu, Kenya, April – December 2015 (9 months).

External grants (after dissertation, >100 000 SEK)
as main applicant:

Sida (through the research programme AgriFoSe). "Meta-analysis of the effects of annual mixed cropping on pest, disease and weed control" 2016-2017, approx. 320 000 SEK.
Swedish foreign ministry (thorugh SLU Global). "Metaanalysis on interventions to improve pest management and soil health in the humidtropics" 2013-2014, 600 000 SEK.
BiodivERsA/Formas: "Assessment and valuation of Pest suppression Potential through biological control in European Agricultural Landscapes (APPEAL)" 2012-2015, 2 250 000 SEK; coordinator.
Formas "The importance of natural enemy diversity and food-web structure for biological control at organic and conventional farms" 2010-2015, 4 264 000 SEK.
Formas postdoc-stipend "Betydelse av nektar för samhällsstruktur och biologisk kontroll: konsekvenser för fitness och spridning hos parasitoider och hyperparasitoider som angriper bladlöss" 2005-2006 (1 year). 430 000 SEK.
Stiftelsen Oscar och Lili Lamms minne " Naturvårdsnytta och ekonomisk kostnad för olika bevarandeåtgärder i det svenska skogsbruket" 2002-2005, 920 000 SEK.

as co applicant:

Sida, Open Call process for the Swedish Research Training Partnership Program with Uganda. " Building Research and Training capacities to develop innovations in sustainable intensification of maize–based cropping systems for improving productivity, food security and resilience to climate change in Uganda" 2015-2020, 8 700 000 SEK.

Linneus Palme, teacher exchange between SLU and Embu University, Kenya, 2015-2016, 171 000 SEK

Swedish foreign mininstry (UD40),"The importance of landscape and local structure for biological control" 2011-2012, 1 000 000 SEK.

Formas "Ekonomiska analyser av naturvårdsanpassningar i svenskt skogsbruk" 2002-2004, 1 980 000 SEK.

Swedish Energy Agency "Påverkan av GROT-uttag på insekter, lavar och svampar på landskapsnivå och i ett 100-årsperspektiv", 2005, 550 000 SEK.

Postdoc mentorship

- Lorena Pumariño, May 2013 – August 2014.
- Riikka Kaartinen, January 2013 – May 2015.

PhD- supervision

Completed

-Main supervisor for PhD student Eve Roubinet, completed 2016, SLU, Uppsala

-Adviser for PhD-student Sofia Orre, completed 2010, Lincoln University, New Zealand

Ongoing

-Associate supervisor for PhD student Ylva Nyberg, since 2010, SLU, Uppsala

Msc and Bsc supervision

Have supervised 3 master students and 6 bachelor students

PhD-courses

Organiser of two PhD courses: Food-web interactions and stability 2011, and Statistics in practice 2011.

Teacher at 3 PhD courses: Biological Control and Soil health 2012; How to write scientific papers yearly 2010-2014; Plant protection biology 2012.

Undergraduate teaching

Currently responsible for teaching of plant protection for agronomy students at different levels (approx. 10% of position)

Have in the past taught a range of other courses such as Insect ecology, Landscape Ecology, Ecological methods, Entomology

Commissions, awards (selection)

-50% commission as researcher responsible for biological control using insects and arachnids at Centre for Biological Control (CBC), SLU. Ongoing, since Oct. 2011.

- Subject editor for Journal of Pest Science since 2011 and for Peer J since 2012.
- External reviewer for four international research applications: National Fund for Scientific and Technological Development (FONDECYT), Chile, 2009; BioivERsA /FACCE-JPI, EU, 2014; United States – Israel Binational Agricultural Research and Development Fund (BARD), 2015; NERC Science of the Environment, UK, 2015.

- Coorganiser of "3rd International Symposium on Biological Control of Arthropods" Christchurch, New Zealand, 8-13 Feb. 2009.
-Coorganiser of the symposium "Insects and Ecosystem Services" at XXIII International Congress of Entomology, Durban, South Africa, 6-12 July 2008.
- Participated in two evaluation committee for PhD (SLU, 2011, 2013), external examiner in one 2015, Lincoln University, New Zealand, chairman of one oral defence, 2014, SLU.
-Manuscripts refereed for 39 scientific journals, one conference proceeding and one book chapter.
-Award for one of the ten most highly cited papers in the journal Biological Control 2008-2010. Paper: Jonsson, M., Wratten, S.D., Landis, D.A. & Gurr, G.M. 2008. Recent advances in conservation biological control of arthropods by arthropods. *Biological Control*, 45, 172-175.
- Invited member for expert group evaluating scientific evidence for farmers actions to enhance pest control. (2014, The University of Cambridge, UK in collaboration with the food retailer Waitrose).
- Invited member of expert group to develop landscape level pest control models for the modelling tool InVEST, SESYNC, Annapolis, USA 2014-2016.
- Invited scientific expert to the Flavoscence Doree working group, Winetwork, France 2015-2016.
- Current member of board for stakeholder interactions at SLU, and advisory board for agronomy education at SLU.

Oral presentations at conferences and university departments
-27 oral presentations given at conferences and symposia.
-14 oral presentations given at universities and research institutes.

Communication with stakeholders and the public
- Coorganiser of a stakeholder conference on biological control 2012.
- Coorganiser of a symposium and inauguration of Centre for Biological Control 2012.
- Invited speaker at two field days in New Zealand 2007 and Sweden 2013.
- Invited speaker at two courses for agricultural advisers 2011, 2012.
- Invited lecturer at two courses for farmers 2013.
- Invited speakers at four stakeholder conferences 2004, 2013, 2013, 2014.
- Invited speaker at Swedish Chemicals Agency 2013.
- Discussion with the public in monter at Borgeby field days 2013.
- Discussion with public at open house day, SLU 2014.
- Press releases 2002, 2014, 2015, 2016
- Popular articles in Fakta Skog, Växtskyddsnotiser, Ekologist Lantbruk, Greppa Växtskyddet etc
- Interviewed by newspaper Västerbottenskuriren 2016.
- Updated Wikipediatext about Biological Control in Swedish 2014.
- Various contributions to the CBC-website (news items, videos, texts etc) http://www.slu.se/cbc

Scientific publications
38 peer reviewed scientific publications, H index: 14.

Doc. RNDr. Pavel Saska, Ph.D.

* 1977

specialization:

Ecology and biology of insects and other soil-inhabiting arthropods in agroecosystems, insect-plant interactions, including seed predation, environmental factors of insect development and distribution.

education:

2000: M.Sc. at Department of Zoology, Faculty of Science of the Charles University.

Thesis: Larval biology and taxonomy of central European species of the subgenus *Amara* (Coleoptera: Carabidae). Supervisor: Prof. RNDr. K. Hůrka, DrSc.

2005: Ph.D. at Department of Zoology, Faculty of Science of the Charles University.

Thesis: Ecology of granivorous ground beetles and their beetle parasitoids (Coleoptera: Carabidae). Supervisor: RNDr. A. Honěk, CSc.

2005: RNDr. Faculty of Science of the Charles University.

professional experience:

2001 – 2014: researcher/entomologist at Department of Entomology, Crop Research Institute, Prague.

2003 – 2004: Fellowship of the EU programme Mme Marie Curie Training Site at Graduate School of Production Ecology and Conservation Resources (PE&RC), Wageningen University, Wageningen, the Netherlands (9 months).

2006: Fellowship Onderzoekersbeurs at Graduate School of Production Ecology and Conservation Resources (PE&RC), Wageningen University, Wageningen, the Netherlands (3 months).

2008: Fellowship Onderzoekersbeurs at Graduate School of Production Ecology and Conservation Resources (PE&RC), Wageningen University, Wageningen, the Netherlands (4 months).

2008 – now: assistant (part time) at Department of Ecology, Czech University of Life Sciences, Prague.

2010: docent (Associate Prof.. equivalent) at Department of Ecology, Czech University of Life Sciences, Prague.

2014 – now: group leader Functional diversity of invertebrates and plants in agroecosystems, Crop Research Institute, Prague

Membership in scientific societies:

Czech Entomological Society

Czech Mycological Society

Czech Herbological Society

European Weed Research Society

Scientific papers (1999-2016): 48 (36 with IF), h-index = 14 (WoS), 17 (Google Scholar)

CV Wopke van der Werf

Wageningen University, Department of Plant Sciences
Centre for Crop Systems Analysis, Crop & Weed Ecology Group
Droevendaalsesteeg 1, 6708 PB Wageningen, The Netherlands

E-mail: wopke.vanderwerf@wur.nl
URL: http://www.wageningenur.nl/en/Persons/Wopke-van-der-Werf.htm#

Research areas
Spatial ecology and ecosystem services in agricultural landscapes
Ecology of intercropping
Invasive species risk assessment

Scientific career
BSc Crop Science & MSc Crop Protection, 1997-1983
PhD Wageningen University, 1984-1988
Assistant professor Wageningen University, Theoretical Production Ecology, 1988-1999
Assistant professor Wageningen University, Crop & Weed Ecology, 1999-2001
Associate professor, Crop & Weed Ecology, 2001-present
Extended periods of academic work (sabbaticals) in the USA (6-11 months) in 1992, 1999, 2003 and 2009

ACADEMIC POSITIONS
Acting head of crop & weed ecology group (2000-2004)
Chair of program committee Plant Sciences (2001-2008)
Task leader for modelling spread of invasive species in EU project Pratique (2007-2011)
Workpackage leader for Durability of IPM approaches in EU project PURE (2011-2015)
Workpackage leader for Modelling and upscaling of ecosystem service provisioning in agricultural landscapes in EU Project QUESSA (2013-2017)
Member of Plant Health Expert Panel and working groups of European Food Safety Authority (2013- …)

SCIENTIFIC OUTPUT
Publications:
- Number of publications in peer-refereed international journals: (143 in WoS; 2016-05-31)
- Number of citations according to WoS: 2108; H-index: 24; average citations per publication: 14.7
- Author of "Sampling and monitoring in crop protection" by Binns, Nyrop & van der Werf, CABI, 2000.

Supervision of PhD students and postdocs:
- Number of past PhD students: 22. Current PhD students: 8. Currently 3 postdocs.

Academic teaching:
- Population & Systems Ecology (CSA-20806)
- Diversity and productivity in plant systems (CSA-32806)
- Ecological Modelling and Data Analysis in R (CSA-50306)
- Agrobiodiversity (SOQ-50806)
- Plant Quality & Integrated Pest Management (ENT-20806)

SELECTED PUBLICATIONS IN RECENT 5 YEARS

Geertsema W, Rossing WAH, Landis DA, Bianchi FJJA, van Rijn PCJ, Schaminée JHJ, Tscharntke T, **van der Werf W** (2016) Actionable knowledge for ecological intensification of agriculture. Frontiers in Ecology and the Environment 14: 209–216. http://dx.doi.org/10.1002/fee.1258

Gou, Fang; van Ittersum, Martin, Wang, Guoyu, van der Putten, Peter, **van der Werf, Wopke** (2016) Yield and yield components of wheat and maize in wheat-maize intercropping in the Netherlands. European Journal of Agronomy 76, 17–27. http://dx.doi.org/10.1016/j.eja.2016.01.005

Mao LL, Zhang L, Evers JB, Henke M, **van der Werf W**, Liu SD, Zhang SP, Zhao XH, Wang BM, Li ZH (2016) Identification of plant configurations maximizing radiation capture in relay strip cotton using a functional-structural plant model. Field Crops Research 187(1), 1–11. http://dx.doi.org/10.1016/j.fcr.2015.12.005

Van Oort PAJ, Wang GY, Vos J, Meinke H, Li BG, Huang JK, **van der Werf W** (2016) Towards groundwater neutral cropping systems in the Alluvial Fans of the North China Plain. Agricultural Water Management 165, 131–140. http://www.sciencedirect.com/science/article/pii/S0378377415301608

Yu Y, Stomph TJ, Makowski D, **van der Werf W** (2015) Temporal niche differentiation increases the land equivalent ratio of annual intercrops: a meta-analysis. Field Crops Research 184, 133–144. http://dx.doi.org/10.1016/j.fcr.2015.09.010

Bahlai CA, **van der Werf W**, O'Neal MW, Hemerik L, Landis DA (2015) Shifts in dynamic regime of an invasive ladybeetle are linked to the invasion and insecticidal management of its prey. Ecological Applications 25(7), 1807–1818. http://www.esajournals.org/doi/pdf/10.1890/14-2022.1

Zhu JQ, **van der Werf W**, Anten NPR, Vos J, Evers JE (2015) The contribution of phenotypic plasticity to complementary light capture in plant mixtures. New Phytologist.

Bianchi FJJA, Walters BJ, ten Hove ALT, Cunningham SA, **van der Werf W**, Douma JC, Schellhorn NA (2015) Early-season crop colonization by parasitoids is associated with remnant native vegetation, but is spatially and temporally erratic. Agriculture, Ecosystems and Environment 207, 10–16.

Cong WF, Hoffland E, Li L, Janssen BH, **van der Werf W** (2015) Intercropping affects the rate of decomposition of soil organic matter and root litter. Plant Soil 391, 399–411.

Cong WF, Hoffland E, Li L, Six J, Sun JH, Bao XG, Zhang FS, **van der Werf W** (2015) Intercropping enhances organic carbon and nitrogen in soil. Global Change Biology 21: 1715–1726.

Allema AB, **van der Werf W**, Groot JCJ, Hemerik L, Gort G, Rossing WAH, van Lenteren JC (2015) Quantification of movement of carabid beetles in farmland. Bulletin of Entomological Research 105, 234–244.

Soliman T, Mourits MCM, Oude Lansink AGJM, **van der Werf W** (2015) Quantitative Economic Impact Assessment of Invasive Plant Pests: What does it require and when is it worth the effort? Crop Protection 69, 9-17.

Cong WF, van Ruijven J, **van der Werf W**, De Deyn G, Mommer L, Berendse F, Hoffland E (2015) Plant species richness leaves a legacy of enhanced root litter-induced decomposition in soil. Soil Biology & Biochemistry 80, 341-348.

Zhu JQ, Andrieu B, Vos J, **van der Werf W**, Fournier C, Evers JB (2014) Towards modelling the flexible timing of shoot development: simulation of maize organogenesis based on coordination within and between phytomers. Annals of Botany.

Zhu JQ, Vos J, **van der Werf W**, van der Putten PEL, Evers JB (2014) Early competition shapes maize whole-plant development in mixed stands. Journal of Experimental Botany, 65: 641 - 653.

Zhou K, Huang J, Deng X, **van der Werf W**, Zhang W, Lu Y, Wu K, Wu F (2014) Effects of land use and insecticides on natural enemies of aphids in cotton: First evidence from smallholder agriculture in the North China Plain. Agriculture, Ecosystems and Environment, 183: 176 - 184.

Saska P, **van der Werf W**, Hemerik L, Luff ML, Hatten TD, Honěk A (2013) Temperature effects on pitfall catches of epigeal arthropods: a model and method for bias correction. Journal of Applied Ecology, 50:181-189.

Soliman T, Mourits MCM, Oude Lansink AGJM, **van der Werf W** (2013) Economic justification for quarantine status – the case study of *'Candidatus* Liberibacter solanacearum' in the European Union. Plant Pathology, 62: 1106-1113.

Mao LL, Zhang L, Li WQ, **van der Werf W**, Sun JH, Spiertz, H, Li L (2012) Yield advantage and water saving in maize/pea intercrop. Field Crops Research, 138: 11–20.

Robinet C, Kehlenbeck H, Kriticos DJ, Baker RHA, Battisti A, Brunel S, Dupin M, Eyre D, Faccoli M, Ilieva Z, Kenis M, Knight J, Reynaud P, Yart A, **van der Werf W** (2012) A suite of models to support the quantitative assessment of spread in pest risk analysis. PLoS ONE, 7(10): e43366.

Zwart MP, Hemerik L, Cory JS, de Visser JAGM, Bianchi FJJA, Vlak JM, van Oers MM, Hoekstra RF, **van der Werf W** (2009) An experimental test of the independent action hypothesis in virus-insect pathosystems. Proceedings of the Royal Society Series B, 276: 2233–2242.

Landis DA, Gardiner MM, **van der Werf W**, Swinton SM (2008) Increasing Corn for Biofuel Production Reduces Biocontrol Services in Agricultural Landscapes. Proceedings of the National Academy of Sciences 105(51), 20552-20557; http://dx.doi.org/10.1073/pnas.0804951106