

Technical Annex 1

Scientific description of the project

Title: The role of Organic Farms as refugia for biodiversity

Acronym: Refugia

Duration: From: 01.01.2007 to: 31.12.2010

Participating scientists:

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English summary

Organic farming generally is acknowledged for the positive effects on biodiversity and other landscape services. However, the intensity of farming has changed significantly through the last decade as ranks of traditional holistic organic farmers has been augmented by much more economically driven new organic farmers. At the same time there have also been steady improvements in farming methodology and crop types resulting in efficiency in organic farming which can often rival its conventional counterparts. Therefore, large variations occur between organic farms. The present project aims at increasing society's and consumers' knowledge about the impact of organic farming on nature by investigating the role of different types of organic farms as refugia for biodiversity.

This is addressed within the work packages 2-7 by:

- 1) Investigating the structure, diversity and intensity of organic farming, and its role for multifunctionality in Denmark. (WP 2)
- 2) Investigating weed-insect food chains for two crops within intensively and extensively cultivated organic fields in order to compare with existing data for conventional farms. This will give information about the amount of non-crop food available for birds and small mammals feeding in the fields and about whether organic fields sustain more food chains than conventional fields. (WP 3)
- 3) Investigating the plant produced food resources in terms of flowering period and weed seeds available for insects, birds and small mammals in hedges and field margins at organic and conventional farms. The data will show whether the documented differences in the flora between hedge vegetation at organic and conventional farms are mirrored in the resource availability. (WP 4).
- 4) Investigating the role of organic farms as genetic sources for species in the arable land by analysing the genetic diversity and population structure of “wild” species in the arable landscape. This will be performed assuming firstly that the upland habitats in hedgerows and fields/grassland of organic farms function both as islands and corridors connecting the islands for flora and fauna, and secondly, that the use of pesticides in conventional agriculture causes frequent local extinction and re-colonisation events of weed and invertebrates. Such events will indirectly affect smaller mammals and farmland birds due to local extinction of food-items. The impact on genetic structure may vary according to the species in question depending amongst others on the species’ dispersal ability. This will be addressed by focussing on the three species, grey partridge (*Perdix perdix*), ground beetle (*Pterostichus spp.*) and field vole (*Microtus agrestis*) representing three different taxa with different dispersal abilities (WP5 and 6).
- 5) Investigating the impact that organic farms have on the wildlife content of the landscape by creating a set of landscape configurations using the information from WP2 on the agricultural extensiveness and distribution of organic farms and from WP 2, 3 and 4 on the species ecology, genetic patterns and species diversity. Modeling tools will be used to synthesize this information and to create a set of indices for describing the ability of a landscape configuration of organic farms to support a range of wildlife. The resulting landscape wildlife index (LWI) will have the potential to be used by interest groups to determine which scenarios result in the optimum wildlife potential from their particular viewpoint (WP7). This index will provide an effective way of measuring ‘nature quality’ from a faunal perspective and will provide the ability to make a direct estimate of the contribution of organic farms to the overall value of the landscape for a range of agricultural species. In this way an organic farmer can evaluate the impact that he could have as an individual on biodiversity via the choices he might make regarding the intensity with which he farms.

A.0 Introduction, state of the art and objectives of the project

The Rio-convention defined the biodiversity concept as consisting of three components (genes, species and ecosystems), which are often regarded as the biological resources in society. So far focus of conservation of biodiversity has primarily been directed towards conservation of selected non-arable wild nature areas containing rare and/or threatened species or ecosystems (Pihl et al. 2000). However, conservation of biodiversity does not only refer to conservation of rare nature, but may just as well be relevant to preservation of more ordinary nature as the one characteristic for the arable landscape and hence represented on organic and conventional farms.

It is a generally accepted view that organic farming gives rise to higher species richness than conventional farming. Hole et al. (2005) has reviewed the literature on the impact of organic farming on biodiversity, and they found that organic farming generally is beneficial to biodiversity. Arable flora, invertebrates, birds and mammals all benefit from organic farming in terms of improved species richness and /or increased abundance. Unfortunately, less than 30% of the studies reviewed by Hole et al. (2005) were published in this century and the investigations described in

these publications are very often some years older. In the review by Hole et al. (2005) only four studies were of Danish origin. Only one of these was from this century. As organic farming has developed quickly in Denmark since the onset of the organic boom in the mid nineties, the conclusions of the older studies may no longer be valid. Therefore, there is a need for new comparative studies in Denmark.

The one recent Danish study included in Hole (2005) (described in Aude 2003 and Bruus Pedersen et al. 2004) and two further studies (Aude 2004, Petersen 2004) have documented that the species diversity of plants and some insects in hedges and field boundaries is higher on organic farms than on conventional farms. This leaves the question of whether this also applies to the organic fields and what the increased botanical diversity in organic borders and hedges means to beneficial insects such as bees and insects with aesthetic value such as butterflies. Finally, it is unknown if the increased botanical diversity adds to the aesthetic value by having more flowers and if the seed production is higher, resulting in more food for insects, birds and small mammals.

Currently, EU research projects concerning developments of multifunctional landscapes elaborate methods to study structural changes in agriculture (Damgaard et al., 2005, www.meascope.org, www.landscape-tomorrow.org). In line with earlier DARCOF research (Langer 2003), and other Danish Studies on the developments in agricultural landscapes (Hansen 2004; Dalgaard et al. 2003), organic farming is found to have positive effects on biodiversity and other landscape services. However, large variations occur between farm types (Kristensen and Kristensen 2004), and over time the intensity of farming have changed significantly (Dalgaard and Kyllingsbæk 2003). Via combination of farm statistics in the EU FADN/RICA network (Rygnestad et al. 2002) and site-specific farm data from land-parcel information systems and national farm databases (Dalgaard et al. 2002b) trends in the intensity and structure of organic farming can now be studied. Denmark has been in the very forefront, collecting these data for all farms applying EU subsidies (Pedersen 2005). From these data, development trends in diversity can be studied nationally at field, farm and landscape scale (Dalgaard et al. 2003), using the latest advances in remote sensing (Bøcher 2003, Bøcher and McCloy 2005a,b), and information system technologies (Kristensen and Rasmussen 2002).

Declines in breeding populations of some farmland birds such as yellowhammer, skylark and corn bunting are thought to have been driven by increased winter mortality resulting from reduced availability of seed food in modern farming systems in the UK (Thomson et al. 1997, Siriwardena et al. 1999, 2000, Peach et al. 1999). Equally, many small mammal species are likely to be affected by the reduction in insect and weed seed food resources resulting from intensification (Flowerdew 1997). The few Danish investigations on small mammals (small carnivore mustelids, shrews, voles and mice) in arable land, which have all been performed in conventional farms, show that intensive agriculture only leaves little room for small mammal species and their abundance is low, especially within fields (Jensen 2001, Jensen & Hansen 2003). Both the changes from spring cereals to winter cereals and the decline in areas with stubble fields but also the general decline in weeds and in weed seed bank contribute to the reductions in seed availability within fields (Andreasen et al. 1996, Rich et al. 1996, Wilson et al. 1999). Therefore, the production of seeds in uncropped areas such as field margins and hedgerows becomes of increasingly importance to the farmland birds and small mammals (Fuller et al. 2004). The amount of seeds produced within these areas is, however, unknown, as is the importance of the observed differences in species diversity between hedge vegetation on conventional and organic farms.

Both foreign and Danish studies indicate that part of the multifunctionality of organic farming may be to serve as a refuge for plants, invertebrates, mammals and birds that are decreasing in abundance in the conventional landscape. In this manner organic farming can be a key factor in preserving the biodiversity that is decreasing or no longer present in conventional agriculture. Furthermore, herbivorous food webs may still be found in arable land, but within conventional

Danish fields they barely exist except for food chains involving aphids (Topping et al., in press). This is most likely caused by the very low weed amount in Danish conventional fields (often less than 1 g/m² in June), which is a historical minimum, and which may be too low and too scattered to support a fauna of insects accompanying the weeds. In 1987-88 Hald & Redersen (1990) found a substantially higher weed biomass in organic cereal fields than in conventional ones (59 g/m² versus 11 g/m² in June). Equivalently, total arthropod density, diversity and biomass were higher in organic cereal fields (Hald & Reddersen 1990). Unsprayed fields and organically grown fields generally still support more weeds than conventionally grown fields (Rydberg & Milberg 2000, Salonen et al 2001), although modern organic farming combats weeds rather efficiently by mechanical means. Therefore, it is very likely that the density of weeds in organic fields is high enough to support a fauna of herbivorous insects on the weed flora, and that the weeds and the accompanying insect can spread from organic fields to the neighbouring conventional fields, if conditions there improves.

In theory, organic farms could play an important role in the agricultural landscape as refuges for some small mammal species, as the lack of pesticide and fertiliser treatment, less weed control, more diversified crop structure and a general environmental-friendly attitude, form a basis for habitats that provide cover and food for small mammals, and thus for larger predators of these species. Furthermore, density and area of small biotopes could be expected to be higher in the organic farms, thus leading to a decreased distance between optimal habitats.

In practice, differences within organic farms can be expected, intensive organic farms providing less optimal conditions than traditional organic farms.

Even for higher organisms such as birds and small mammals, knowledge about the population structure with respect to the connection between farmland and non-farmland habitats or between habitats in organic versus conventional farms is absent (Fuller et al. 2004). This information is essential if we are to understand the role that different farm types have in shaping the distribution of animal populations and in preserving genetic diversity of “wild” species. These roles have never been addressed before. Studies addressing preservation of genetic diversity in organic farming mostly deal with maintenance of local distinctiveness and genetic diversity of the crop.

Individuals and genes from organic farms can disperse and recolonise conventional fields if for instance the farming turns pesticide-free, but also in general after each local extinction. In this way part of the multifunctionality of organic farming will be to serve as a biological reserve important for the preservation of species and populations (genes) and of great value not only locally but also at an unknown regional scale. This theory of the role as refugia embracing all three components of the biodiversity concept has yet not been addressed in DARCOF research, and forms an exciting novel aspect to this proposal.

Improved nature content is a major reason why consumers are willing to pay a higher price for organically grown commodities. It is therefore of utmost importance to organic farming that consumers get as much knowledge as possible about the beneficial nature effects of organic farming. Organic farming is dependent on telling good stories to the public. However, organic farming must also be an effective farming form, hence it is important to be able to determine the impact of the increase in effectiveness and the interplay between this and the benefit for wildlife. To be truly multifunctional organic farming should both be efficient and ‘nature friendly’.

Objectives of the project

Visionary objectives: To increase society's, decision-makers and consumers' knowledge about the multifunctional role of organic farming- especially focusing on the impact of organic farming on nature.

Immediate objectives:

To investigate food chains, species diversity and genetic diversity and cohesion in the wild flora and fauna in organic farming related to conventional farming, and to test the following refugia hypotheses:

Hypotheses

- 1) Species diversity is higher in ecosystems found in organic fields compared to conventional fields. Population sizes of many species are still higher in organic fields compared to conventional farming – even on intensive organic farms.
- 2) Extensively cultivated organic fields have higher species numbers and higher densities of weeds and arthropods than intensively cultivated organic fields
- 3) Organic farms possess a higher number of functioning weed – herbivore food chains than conventional farms, which gives the foundation for more insect life in organic fields.
- 4) The documented differences in herbal species richness and composition between organic and conventional borders and hedges result in higher availability of plant produced food, e.g. weed seeds.
- 5) Organic farms have a role as refuges (food chains, species- and gene bank) for the species in the arable land that are declining in the conventional farmland.
- 6) The local extinction of plants, invertebrates and smaller mammals happens more frequently on conventional farmland due to use of pesticides, structural differences (fewer suitable habitats) and different ways of production, that reduces the biodiversity at the species and gene level

A.1 Technical content of the research activity

Overview of methodology

Overall Methods

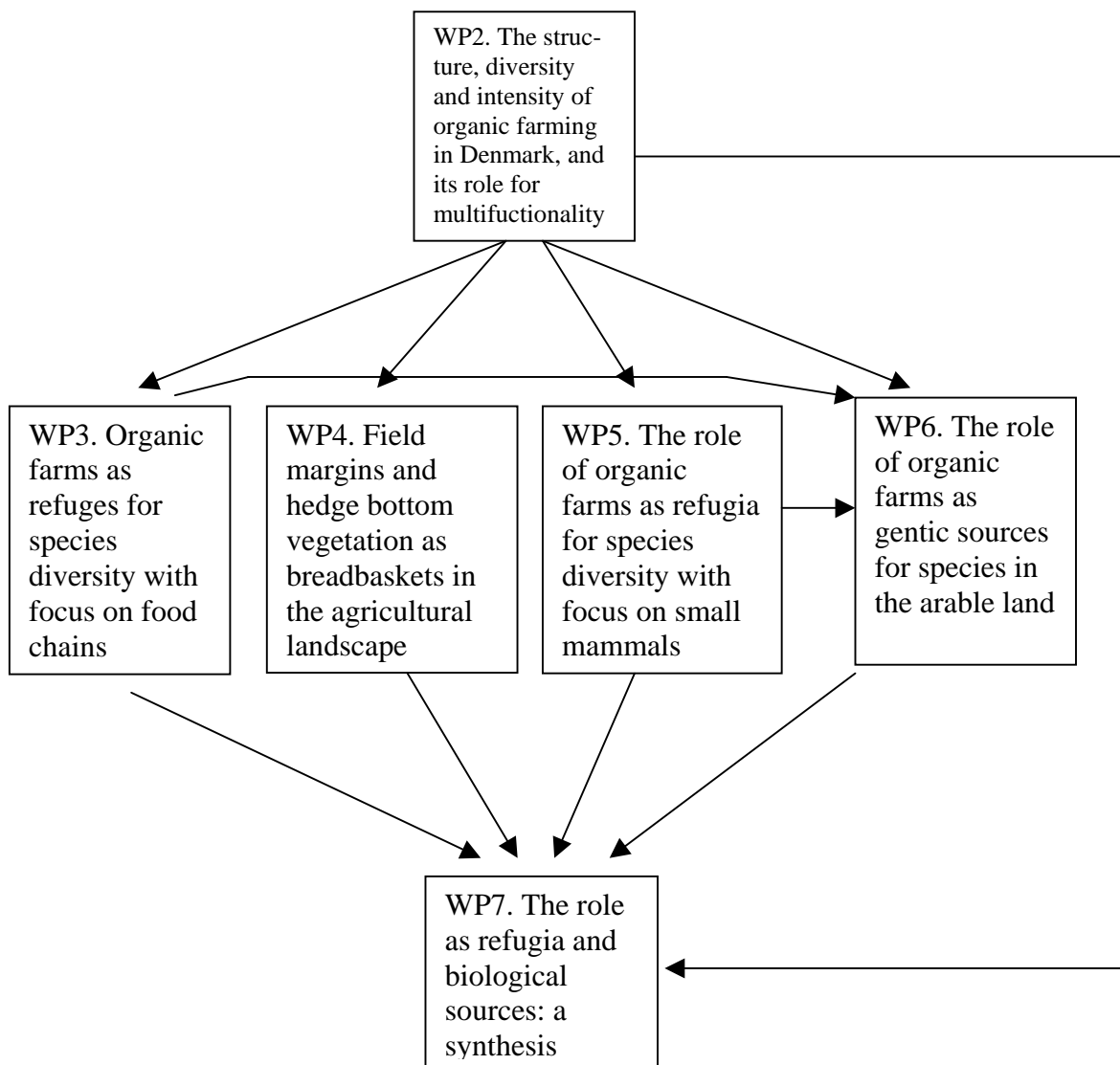
The project consists of four connected parts:

1. Organic farms as “habitat/food chain banks” will be investigated by analysing the structural differences in the landscape between organic and conventional farms.
2. The abundance and diversity of weeds, mammals and insects in organic fields will be documented by focussing on food webs. The results will be correlated, partly to existing data from conventional fields (Jensen & Hansen 2003, Topping et al. 2004, in press) and partly to existing data from organic and conventional hedgerows/hedges (Bruus Pedersen et al. 2004) and to data collected during the project
3. Borders and hedges on organic farms as food resources for farmland insects, birds and small mammals will be studied in terms of plant produced food, e.g. weed seed production.
4. Organic farms as “gene sources/gene banks” will be studied by
 - a) analysing the genetic diversity in the three chosen species grey partridge (*Perdix perdix*), a ground beetle (*Pterostichus spp.*) and field vole (*Microtus agrestis*).
 - b) analysing the population's cohesion/connection (metapopulation structure) by estimating and modelling migration directions and rates between and within organic and conventional farms.
 - c) estimating the critical sizes and distances for organic farms and small biotopes.

- The studied examples of biodiversity will be integrated into a spatial modelling framework. This will allow the results to be generalised and by applying some simplifying assumptions of life-history and migration classes to give an overall assessment of the importance of organic farms as refugia for biodiversity. Furthermore, the modelling framework will be used to predict the influence of a change from extensive to intensive organic agricultural practice on biodiversity by performing various scenario simulations with different configurations of organic farm types. Results will be collated into a landscape wildlife index capable of describing the ability of a landscape configuration of organic farms to support wildlife.

A diagram of the information flow in between the seven WP's is outlined in Figure 1 and the time table in Table 1 outlining the plan for the project..

Figure 1. Diagram of the information flow in the project.



Application form

Research in Organic Food and Farming

Work Package list

WP No.	WP title	Responsible scientist	Budget DKK	Start	End	Deliverable No.
1	Project management	LWA	161.941	03.01.2007	31.12.2010	D1.1-D1.2
2	The structure, diversity and intensity of organic farming in Denmark, and its role for multifunctionality.	TDA	708.920	03.01.2007	31.03.2010	D2.1-D2.4
3	The role of organic farms as refuges for species diversity with focus on food-chains.	MBP	1.375.398	03.01.2007	31.12.2010	D3.1-D3.5
4	Field margins and hedge bottom vegetation as “breadbaskets” in the agricultural landscape.	BST	455.335	03.01.2007	31.12.2010	D4.1-D4.4
5	The role of organic farms as refugia for species diversity with focus on small mammals.	TSJ	1.278.954	03.01.2007	31.12.2010	D5.1-D5.6
6	The role of organic farms as genetic sources for species in the arable land.	LWA	2.169.942	03.01.2007	31.12.2010	D6.1-D6.5
7	The role as refugia and biological sources: a synthesis.	CJT	836.796	03.01.2007	31.12.2010	D7.1-D7.4
Total			6.987.286			

Deliverables list

Deliverables list

Deliverable No	Deliverable title	Lead scientist	Delivery date	Allocated scientific person months	Type of deliverable
D1.1	Annual status report including milestones from all WP's	LWA	31.12.2007 31.12.2008 31.12.2009 31.12.2010	0,5 0,5 0,5 0,5	R R R R
D 1.2	Final report of the results of the WP's	LWA (all)	31.12.2010	1	R
D 2.1	A popular paper on the multifunctional role of organic agriculture in Denmark.	TDA	31.09.2008	1,2	P

D 2.2	Web based maps over organic farming structure and development in Denmark	MBG	31.03.2009	2,98(tech).	O
D 2.3	A scientific paper submitted on the development of remote sensing techniques for analysing within field structural diversity. The paper will include a comparison of different fields from organic and conventional farms in order to try to identify significant differences between organic and conventional farms.	PKB	31.03.2010	4	S
D 2.4	A scientific paper submitted on the multifunctional role of organic agriculture (co-deliverable with the DARCOFIII financed project Bioconcens. Case study on the multifunctional role of organic bioenergy production).	TDA	31.03.2010	2,05	S
D 3.1	A scientific paper comparing the weed density and diversity in organic with the measurements from conventional farming from Topping et al. (2004).	MBP	submitted 30.06.2009	3,0	S
D 3.2	A scientific paper comparing the insect density and diversity in organic with the measurements from conventional farming from Topping et al. (2004).	MBP	submitted 31.01.2010	3,0	S
D 3.3	Popular publication comparing weed and insect diversity and densities in extensively and intensively cultivated organic fields.	MBP	submitted 31.03.2010	1,75	P
D 4.1	A scientific paper on flowering period, flowering frequency and seed production in hedges on organic and conventional farms.	BST	submitted 31.03.2010	2,2	S
D 4.2	A popular Danish publication on flowering period, flowering frequency and seed production in hedges on organic and conventional farms.	BST	submitted 31.12.2010	1,1	P
D 5.1	Publication 1: Dispersal patterns of small mammals in organic and conventional farms (submitted, April 2008)	TSJ	30.04.2008	8	S
D 5.2	M.Sc. Thesis (June 2008)	TSJ	31.07.2008	1	O
D 5.4	Publication 2: Small mammal diversity and density in organic and conventional farms (submitted March 2008)	TSJ	31.03.2009	8	S
D 5.5	Congress poster 2: As above (August 2009)	TSJ	31.08.2009	0,5	O
D 5.6	Congress poster 1: As above (August 2010)	TSJ	31.08.2010	1	O
D 6.1	Scientific publication: Genetic dispersal rate and direction of the field vole <i>Microtus agrestis</i> . Conventional versus organic farming (Ph.D).	LWA	submitted 31.07.2010	4	S

D 6.2	Scientific publication: Genetic dispersal rate and direction of the grey partridge, <i>Perdix perdix</i> . Conventional versus organic farming (Ph.D).	LWA	submitted 31.07.2010	4	S
D 6.3	Scientific publication: Impact of dispersal ability on genetic differentiation and the estimated migration rates and directions in conventional versus organic farming (Ph.D).	LWA	submitted 31.07.2010	4,5	S
D 6.4	Scientific publication: Genetic dispersal rate and direction of the ground beetle, <i>Pterostichus spp.</i> Conventional versus organic farming.	LWA	submitted 31.10.2010	8,9	S
D 6.7	Ph.D. thesis delivered.	LWA	31.07.2010	2	O
D 6.6	Report: The role of organic farms as genetic sources for species in the arable land.	LWA	31.12.2010	3	R
D 7.1	Scientific publication on modelling the impact of landscape configuration of organic farms on the population genetics of field voles (Ph.D.).	CJT	31.07.2010	1,8	S
d 7.2	Scientific publication: Evaluating the interaction between farming management, and organic farm structure and the population and spatial dynamics of the species modelled in ALMaSS.	CJT	30.09.2010	2	S
D 7.3	Scientific publication on the development and application of the landscape index for wildlife.	CJT	31.12.2010	2	S
D 7.4	Report 1: Evaluation of the role of organic farming in the landscape for the range of indicator species chosen.	CJT	31.12.2010	3 + 5 from other VIP	R

(The nature of the deliverables must be indicated by S = publication in scientific journal with peer review; P = publication in journals without peer review; R = reports; C = presentation at meetings and congresses or O = other types of deliverables, e.g., prototypes, models, websites, etc.).

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Milestones list

Milestone No	Milestone title	Lead scientist	Delivery date
M 1.1	Upstart of the project	LWA	03.01.07

M 1.2	Annual co-ordination meeting	LWA	31.08.07 31.08.08 02.09.09 30.08.10
M 2.1	Relevant farm sites for empirical data collection in WP3, WP4, WP5 and WP6 and the modelling in WP7 is defined together with these WPs	TDA	03.01.07
M 2.2	An organic farm typology ready for implementation in GIS	TDA	01.04.08
M 2.3	Farm typology incl. information on organic/conventional farming coupled to field polygons in the GIS-landscapes, and delivered to WP7	TDA	06.06.09
M 2.4	National grid maps of farming structure development in Denmark ready.	TDA	01.12.08
M 2.5	Remote sensed images ready for habitat diversity analysis of organic farms and fields	TDA	31.03.09
M 3.1	Investigation farms selected	MBP	31.03.07
M 3.2	Sampling programme planned in detail	MBP	31.03.07
M 3.3	Sampling programme 2007 finished	MBP	31.07.07
M 3.4	Sampling programme 2008 finished	MBP	31.07.08
M 3.5	Investigation on food chains planned in detail	MBP	31.03.08
M 3.6	Sampling of data for food chain analyses finished	MBP	31.08.08
M 4.1	Sampling programme for flowering period and seed production planned in detail	BST	30.04.07
M 4.2	Sampling programme 2007 finished	BST	30.09.07
M 4.3	Sampling programme 2008 finished	BST	30.09.08
M 4.4	Results made available for the synthesis	BST	31.01.09
M 5.1	Establishment of grids and traplines, genetic sampling	TSJ	31.05.07
M 5.2	Dispersal studies and telemetry of small mammals	TSJ	31.09.07
M 5.3	Genetic sampling publication 1	TSJ	31.05.08
M 5.4	Nature quality sampling	TSJ	31.09.08
M 5.5	Data analysis publication 2	TSJ	31.12.09
M 5.6	Models, synthesis and final report.	TSJ	30.06.10
M 6.1	Testing of primers for the ground beetle, field vole and grey partridge and start of genetic analyses in the laboratory start.	LWA	01.09.07
M 6.2	Ph.D. start	LWA	01.08.07
M 6.3	Genetic analyses of the three species in the laboratory continued from the first sampling period and second sampling period (Ph.D. and technician) finished.	LWA	31.12.08
M 6.4	Genetic analyses of the grey partridge (depending on sampling success) finished.	LWA	31.03.09
M 6.5	Data analyses of the genetic data completed and writing of papers in process. Feeding data to WP7.	LWA	31.12.09
M 6.6	Writing papers and Ph.D. completed (31.07.10).	LWA	31.07.10
M 6.7	Development of migration model for the ground beetle completed and writing of scientific publications (submitted) and report completed.	LWA	31.12.10

M 7.1	Scenario inputs data (configurations) completed	CJT	30.06.08
M 7.2	ALMaSS Scenarios completed	CJT	31.12.09
M 7.3	Development and application of landscape index complete	CJT	30.06.10
M 7.4	Report (D7.1) (Project conclusion)		31.12.10

Description of work packages (this page should be copied for each WP)

WP No.: 1 Project management								
	Start date or starting event: 01.01.2007							
Partner id.	NERI	LWA						
Person-months per participant	3							
Total PM VIP:	3							
Objectives:								
<ul style="list-style-type: none"> To co-ordinate the WP and exchange of knowledge To facilitate the synthesis of all Work Packages in order to fulfil the overall objectives of the project 								

Description of work:
The work package comprises the project management and co-ordination of common activities between the work packages including reporting of milestones within the timeframe given. The work will furthermore include the responsibility of facilitating the common writing and analysis for the scientific synthesis paper based on the results of the different WP's. Dissemination of the progress and reports of the WP's. WP1 will also co-ordinate the preparation of a prospectus for an exhibition based on the scientific results and a general description of organic farming.

Deliverables:
D 1.1 Annual status report including milestones from all WP's
D 1.2 Final report of the results of the WP's

Milestones:
M 1.1 Upstart of the project
M 1.2 Annual co-ordination meeting

WP No.: 2. The structural diversity of organic farming in Denmark, and its role for multifunctionality	
	Start date or starting event: 01.01.2007

Partner id.	DIAS								
Person-months per participant	7,25 VIP 2,98TAP								
Total PM VIP:	7,25								
Total PM	10,33								

Objectives:

- To map & analyse developments in the diversity and intensity of organic farming & land use in Denmark, and the relations to organic farming as a refuge for species in the open land
- To investigate the structure and diversity of organic farming at field-, farm and landscape level, and eventual development trends during the last decade
- To analyse correlations between types of organic farming, the abundance of valuable habitats for biodiversity conservation and species refuge, and the multifunctional role of organic farming in Denmark

Description of work:

As part of the satellite-based remote sensing control of farmers receiving EU subsidies, DIAS collects an extensive farm-field geographical information system (GIS) database, covering about 4% of the agricultural area each year (Pedersen 2005). Moreover, NERI and DIAS have digitised fields for a number of 10x10 km study landscapes in Denmark (Hansen 2004). These data can now be connected to a database (GLR/CHR) over all farms in Denmark (Dalgaard et al., 2002b), and organic farms and fields can be identified (Dalgaard and Jørgensen 2004). In a European context, this creates a whole new opportunity for analysing spatio-temporal developments in organic farming structure and intensity, and the relation to biodiversity conservation.

This WP gathers these data in one GIS, and classifies the organic farms and fields into types of intensity (livestock density, yields, no. of field operations, energy use etc) (Dalgaard et al, 2002a; Kristensen and Kristensen 2004). This information is generalised to grid maps for all of Denmark and the anonymized maps are made public accessible via the www.djf-geodata web-interface. Structures and developments in field sizes, distances between field and farms, nearness to habitats, clumping of organic areas etc. are analysed (Kristensen and Rasmussen 2002; Frederiksen and Langer 2004), using the latest GIS-technologies. Developments in the within field diversity, the abundance of habitats near organic areas, and scale specific structures in relation to biodiversity are investigated via the satellite- and ortho-photo images collected for the yearly remote sensing control zones (Bøcher 2003, Bøcher and McCloy 2005a, b). Finally, the correlations between types of organic farming and the habitat diversity are analysed. Thereby, hypotheses regarding correlations between farm types, farm intensity and habitat diversity can be tested, and spatial patterns and temporal trends interrogated. The findings are presented in the form of maps and figures, which are made public available for research and educational use.

This WP delivers information needed by the other WPs. For example, relevant farms for the sampling in i.e. the sample of fields with different diversity parameters can be supplied for WP3. For WP4 sites and fields with specified surrounding hedgerows can be selected, and for WP5 locations of different types of organic crops and related field practices can be delivered. Finally information on field and farm diversity might show interesting correlations with the genetic diversity analysed in WP6, and GIS themes on farm types and clumping/dispersal of organic farming in the landscape can be supplied for WP7.

Deliverables:

- D 2.1 A popular paper on the multifunctional role of organic agriculture in Denmark (31.09.2008)
- D 2.2 Web based maps over organic farming structure in Denmark (31.03.2009)
- D 2.3 A scientific paper submitted on the development of remote sensing techniques for analysing within field structural diversity. The paper will include a comparison of different fields from organic and conventional farms in order to try to identify significant differences between organic and conventional farm (31.03.2010).
- D 2.4 A scientific paper on the multifunctional role of organic agriculture (co-deliverable with the DARCOFIII financed project Bioconcens. Case study on the multifunctional role of organic bioenergy production) (31.03.2010)

Milestones:

- M 2.1 Relevant farm sites for empirical data collection in WP3, WP4, WP5 and WP6 and the modelling I WP7 is defined together with these WPs (01.12.2006)
- M 2.2 An organic farm typology ready for implementation in GIS (01.04.2008)
- M 2.3 Farm typology incl. information on organic/conventional farming coupled to field polygons in the GIS-landscapes, and delivered to WP7 (06.06.2009)
- M 2.4 National grid maps of farming structure in Denmark ready (01.12.2008)
- M 2.5 Remote sensed images ready for habitat diversity analysis of organic farms and fields (31.03.2009)

WP No.: 3 The role of organic farms as refuges for species diversity with focus on foodchains

	Start date or starting event: 01.01.2007								
Partner id.	NERI	MBP							
Person-months per participant	24 TAP 7,75 VIP								
Total PM VIP:	7,75								
Total PM	31,75								

Objectives:

- To investigate the density and diversity of weeds and weed accompanying insects in organic fields in comparison with existing data from conventional fields (Topping et al. in press)
- To compare weed and insect diversity and densities in intensively and extensively cultivated organic fields

Description of work:

1) The density and diversity of flora and fauna at the species level will be investigated by the same methods as used by Topping et al. (in press) to make comparison with existing data for conventional fields possible. These methods include suction samples by D-vac for insects and subsequent sampling of flora on a number of squares of the size of 0.25 m² within the insect sampling area. Sampling will take place in spring barley and winter wheat on extensively and intensively cultivated organic farms, because material from conventional fields is strongest from these crops. Four fields will be selected within the study area of Topping et al. (in press) for comparison. In these fields sampling will be performed five times in one growth season in. Within the study area of the present project, eight fields will be sampled once in June of project year 1 and 2. On each sampling occasion 12 samples will be taken in each field.

2) A number of “islands” with various densities of some selected weeds will be selected and the densities of the weeds and their accompanying insects will be estimated by the same means as in 1). The weeds with accompanying insects have not been selected yet, but the following ones are good candidates:

1. Shepard purse (*Capsella bursa-pastoris*) as food plant for the butterflies *Anthocharis cardamines* (Aurora) and *Pieris brassicae*
2. Common Chickweed (*Stellaria media*) as food plants for the moths *Caryocolum junctella*, *Coleophora striatipennella*, *Xestia c-nigrum*.
3. Field Pansy (*Viola arvensis*) as food plant for *Issoria lathonia*
4. Ribwort Plantain (*Plantago lanceolata*) as food plant for the butterfly *Melitaea cinxia*
5. Red archangel (*Lamium purpureum*) as food plant for *Perizoma alchemillata*
6. Black Bindweed (*Fallopia convolvulus*) and Knotgrass (*Polygonum aviculare*) as food plant for the leaf beetle *Gastrophysa polygonii*.
7. Cornflower (*Centaurea cyanus*) as food plant for the moth *Agonopterix ciliella*

Deliverables:

- D 3.1 Scientific paper comparing the weed density and diversity in organic with the measurements from conventional farming from Topping et al. (in press.). June 2009
- D 3.2 Scientific paper comparing the insect density and diversity in organic with the measurements from conventional farming from Topping et al. (in press.). January 2010
- D 3.3 Popular publication comparing weed and insect diversity and densities in extensively and intensively cultivated organic fields, March 2010

Milestones:

- M 3.1 Investigation farms selected, March 2007
- M 3.2 Sampling programme planned in detail, March 2007
- M 3.3 Sampling programme 2007 finished, July 2007
- M 3.4 Sampling programme 2008 finished, July 2008
- M 3.5 Investigation on food chains planned in detail, March 2008
- M 3.6 Sampling of data for food chain analyses finished, August 2008

WP No.: 4 Field margins and hedge bottom vegetation as ‘breadbaskets’ in the agricultural landscape

	Start date or starting event: 03.01.2007				
Partner id.	NERI	BST			
Person-months per participant	6,0 TAP 3,3 VIP				
Total PM VIP:	3,3				
Total PM	9,3				

Objectives:

- To investigate the length of the flowering period and the density of flowers in hedges and field margins at organic and conventional farms.
- To investigate the production of weed seeds in hedges and field margins at organic and conventional farms.

Description of work:

Methods:

The length of the flowering period will be calculated as the number of plant species that are flowering along a 100m transect five times during the period April-September within 10 hedges/field margins of each of the farming types as defined in WP 2 (extensive organic, intensive organic, conventional). Sampling will be performed in 2 years (2007 and 2008)

The frequency of flowering will be calculated as number of 1m² subplots out of 10 in which the species is found flowering and density of flowers (extent of flowering) will be calculated in 5 permanent 1m² plots located in a systematic way (see Roy et al. 2003 for methodology). Sampling will be performed in 2 years (2007 and 2008).

Seeds of five species that form an important part of birds and small mammals intake of weed seeds will be harvested in ten 1m² plots within 10 hedges of each of the three farming types. Following harvest the seed will be counted and weighed. Calculation will be done in 2 years (2007 and 2008).

Deliverables:

- D 4.1 A scientific paper on flowering period, flowering frequency and seed production of plants in hedges on organic and conventional farms (March 2010)
- D 4.2 A popular Danish publication on flowering period, flowering frequency and seed production in hedges on organic and conventional farms (December 2010)

Milestones:

- M 4.1 Sampling programme for flowering period and seed production planned in detail. April 2007
- M 4.2 Sampling programme 2007 finished. September 2007
- M 4.3 Sampling programme 2008 finished. September 2008
- M 4.4 Results made available for the synthesis. January 2009

WP No.: 5 The role of organic farms as refugia for species diversity with focus on small mammals

	Start date or starting event: 01.01.2007			
Partner id.	Museum of Natural History, Århus	Thomas Secher Jensen	Tine Sussi Hansen	Tech
Person-months per participant	18,5 VIP 3,5 TAP	2	16,5	3,5
Total PM VIP:	18,5 VIP			
Total PM	22			

Objectives:

- To describe the biodiversity of small mammals in organic fields and conventional fields
- To determine population densities of small mammals in different types of crops according to farming practice
- To identify differences among small mammal population in terms of reproduction, survival and dispersal
- To describe the spatial dynamics of the field vole *Microtus agrestis* in organic and conventional farm landscapes
- To collect small mammal tissue sample for use in genetic analysis
- To develop a nature quality index form small mammals on a farm level.

Description of work:

The present project proposal aims at comparing biodiversity at the community, species and genetic level of small mammals in conventional farms and intensively and extensively grown organic farms. For this purpose we plan to collect data and samples in order to develop a biodiversity index for the small mammal fauna, collect samples for genetic analysis, and collect data for description of dispersal of individuals within and between farms.

The diversity and density of small mammals will be investigated by trapping sessions in a wide range of different fields in conventional and organic farms. The index will be used to evaluate the biodiversity status for whole farms, based on diversity, density, distribution and isolation (fragmentation).

Genetic data will be sampled in organic and conventional farms and used to describe within- and between-variation of field vole DNA.

Furthermore data on vole dispersal will be sampled by and used in the ALMaSS model (Topping et al 2004).

Methods

The diversity and density of small mammals will be investigated by trapping sessions in a wide range of different fields in conventional and organic farms. Eight different areas are chosen for intensive trapping – four of which in conventional fields and the other four in organic fields. Each area will include a wide range of different types of fields and habitats with special focus on the smaller biotopes, e.g. hedgerows, wildlife refuges, surroundings of ponds and set-aside-fields.

Livetrapping will be performed in traplines with 20 meters between traps, including traps designed to capture various small mammal species. These trapping sessions will be repeated 3 times during the year: spring/early summer (before harvest), late summer/autumn (after harvest) and late autumn/winter (after winter sowing). By means of a capture-marking-recapture program (CMR) it is possible to estimate population sizes and density in each of the fields and small biotopes.

Reproduction rates will be determined by 1) field determination of live animals – as pregnant (late gestation) and lactating females can be identified and 2) laboratory examination of dead animals when pregnancy, lactation and former pregnancies as well as litter size in terms of placental scars in uterus can be determined.

Nature quality index on the farm level will be developed based upon upscaling species diversity and density from field samples, taking into account field sizes, crop type, small biotope areas, and distance between field types.

The spatial dynamics of mammals at landscape level will be investigated by means of livetrapping individual, and subsequent marking and telemetry. One species, field vole *Microtus agrestis* will be selected for radio telemetry investigations with the purpose to describe survival and dispersal in the selected areas. Trapping sessions will be repeated at the time when dispersal of individuals is at a maximum, i.e. at pre-harvest and post-harvest times, during 2007. Radio-marked animals will be followed as long as the batteries of the transmitters last.

In the spring when population levels are at the lowest and hence, genetic bottlenecks are likely to occur, field voles will be sampled for genetic analysis and modelling. This will be repeated in 2006

and 2007 in order to account for year-to-year variation in population structure.

Laboratory work:

Examination of dead animals for reproductive characters.

Tissue samples of dead animals for genetic use.

Deliverables:

D 5.1 Publication 1: Dispersal patterns of small mammals in organic and conventional farms (submitted, April 2008)

D 5.2 M.Sc. Thesis (June 2008)

D 5.3 Congress poster 1: As above (July 2008)

D 5.4 Publication 2: Small mammal diversity and density in organic and conventional farms (submitted March 2009)

D 5.5 Congress poster 2: As above (August 2009)

D 5.6 Congress poster 1: As above (August 2010)

Milestones:

M 5.1 Spring 2007: Establishment of grids and traplines, genetic sampling

M 5.2 Summer-autumn 2007: Dispersal studies and telemetry of small mammals

M 5.3 Spring 2008: Genetic sampling publication 1

M 5.4 Summer-autumn 2008: Nature quality sampling

M 5.5 Winter 2009: Data analysis publication 2

M 5.6 Summer 2010: Models, synthesis, publication 3 and final report.

WP No.: 6 The role of organic farms as genetic sources for species in the arable land.

Start date or starting event: 01.01.2007

Partner id.	NERI	LWA	CD	Ph.D.	Technician	NN
Person-months per participant	26,4 VIP 12,8 TAP	10,9	3,5	12	12	0,8
Total PM: VIP	26,4					
Total PM	39,2					

Objectives:

- To investigate the role of organic farming as refugia of genetic diversity for three chosen “wild“ species in the arable land by
 - a) analysing the amount of genetic diversity and possible reduction of genetic diversity (bottleneck) in the chosen species on the organic farms and conventional farms
 - b) analysing the genetic population structure in the chosen species
- To estimate the spatial scale and direction of dispersal for the three chosen species by analysing the genetic diversity between and within organic and conventional farms and model migration.

Description of work:

This work package will analyse the genetic diversity and population structure of “wild” species in the arable landscape.

The hypotheses in the present WP are:

- 1) the upland habitats in hedgerows and fields/grassland of organic farms function both as islands and corridors connecting the islands (refugia-like, metapopulation structure) for flora and fauna
- 2) the use of pesticides in conventional agriculture causes frequent local extinction and recolonisation events of weed and invertebrates. The use of pesticides is thought to have an indirect negative effect on smaller mammals and farmland birds in terms of local extinction of food-items. Hence, it is expected that the local extinction will narrow the level of genetic diversity of the species in conventional agriculture relative to organic farming.

The impact of the described functions of organic farming on genetic structure, diversity and rate of migration of genes depend on the population size, generation time and dispersal ability of the species in question. The impact may therefore vary according to the species in question. This variation in impact will be assessed by focussing on the three species, grey partridge (*Perdix perdix*), ground beetle (*Pterostichus spp.*) and field vole (*Microtus agrestis*) representing three different taxa, birds, invertebrates and small mammals with different dispersal abilities.

Ecology/dispersal ability of the three species**Ground beetle (*Pterostichus spp.*)**

The ground beetle (*Pterostichus spp.*) preferred habitat is uncultivated open land (Fournier & Loreau 2001). It is an autumn breeder and overwinters in the larval stage. Some immature adults overwinter and become mature early spring. It is unable to fly but is able to disperse 18-20m within 24 hours (Hagley 1998). It becomes active in late May-early June and is abundant mid-July to mid-August (Hagley 1998). The only study of the genetic population structure of *Pterostichus spp.* conducted is a recent study including two carabid species, *Abax arter* and *Pterostichus madidus* (Desender et al. 2005). The genetic diversity and differentiation of *Abax arter* and *Pterostichus madidus* were analysed using isozyme markers. Two areas representing different degrees of habitat fragmentation was included in the analysis. The results indicated that *Pterostichus madidus* showed a higher genetic diversity but a lower genetic differentiation compared to *Abax arter*, which could be ascribed to its wider habitat preference. The study also showed that the genetic diversity observed in *Pterostichus madidus* from the less fragmented area was higher and that the genetic differentiation of *Pterostichus madidus* was higher in the more fragmented area as expected (Desender et al. 2005).

Field vole (*Microtus agrestis*)

The field vole (*Microtus agrestis*) is mainly found in open grassy habitats with dense, ungrazed ground cover in the young forestry plantations in woodland clearings and hedgerows. Its dispersal potential is greater relative to the leaf beetle but is restricted by the farmed landscape mosaic surrounding its habitat (Topping et al. 2003). It has been shown that the minimum median natal dispersal distance for males and females were 3 m while the maximum median natal dispersal distance for males were 159 m and 193 m for females (Sutherland et al. 2000). Another study by Norrdahl & Korpimäki (1998) showed a longer dispersal distance for males compared to females. The field vole is territorial during the breeding season and the individuals are philopatric (Sandell et al. 1991). It is also characterised by density-dependent cyclic changes in population growth (Agrell et al. 1996, Hörnfeldt 2004). No genetic study of its population structure, migration rates and directions or genetic consequences of the cyclic population growth has been published.

Grey partridge (*Perdix perdix*)

The grey partridge was originally a bird of temperate steppe grasslands but has adapted to arable farmland and grassland. It is mostly observed in open mixed farmland with small fields and hedges (Potts 1986). In Denmark it has declined over the last 40 years although the total population estimation of breeding pairs has fluctuated during the last 20 years (Bregnballe et al. 2003). It is listed among species with unfavourable conservation status in Europe (Hagenmeijer & Blair 1997). The causes for population decline are amongst others reduced food supplies for chicks, loss of suitable nest sites such as hedge bottoms and rough grassland and nest destruction by early sowing (De Leo et al. 2004). Outside the breeding season the grey partridge is gregarious and found in flocks of 5-25 birds consisting mostly of one or two families. During the breeding season it is loosely territorial (Snow & Perrins 1998). The mean breeding dispersal range of radio-tagged wild hens is 3.1 ± 0.5 km (Putala & Hissa 1998). No study on the genetic population structure, migration rates and directions has been published.

Methods

Sampling design

The sampling design consists of two organic farms and two conventional farms within the same area. The ground beetle and the field vole will be sampled from two localities within a given distance at each farm twice to reduce the effect of stochasticity. As the dispersal ability of the grey partridge is higher compared to the other species the grey partridge will only be sampled from one locality at each farm two years in a row.

Test of hypothesis

- 1) The genetic diversity in the three species can be assessed using variable genetic markers like DNA-microsatellites. Based on the theory of population genetics it is expected to be a positive correlation between population size and mean genetic diversity in populations of a species (Frankham et al. 2002). Hence, a higher population size in organic farming of the three species is expected to lead to a higher genetic diversity.
- 2) When a population size has been low for several generations (bottleneck) the reduction is expected to be reflected in the genetic composition of the population. This can be estimated based on the observed genetic diversity by analysing the association between the level of genetic diversity and the number of alleles (genes) in the population (bottleneck test, Cornuet et al. 1996). (A result of a severe reduction in population size might be inbreeding, loss of genetic diversity and fixation of lethal alleles, which can reduce the evolutionary potential of the population and increase the probability of extinction of the population (Lande 1994, Maudet et al. 2002)). It is expected that bottlenecks will be detected and is more frequent on conventional farms compared to organic farms.
- 3) The genetic relationship (metapopulation structure) between the populations of the species can be estimated using the observed genetic diversity and from this it is possible to get an indication of migration directions and the relative number of individuals migrating from a source to a sink population. The population structure and migration rates and directions will be estimated using a model based on the individuals DNA-profile obtained from the DNA-microsatellite markers used and Bayesian statistics (Pritchard et al. 2000, Wilson & Rannala 2003). It is expected that the different dispersal ability of the three species will be reflected in the genetic differentiation between and within the agricultural systems. The lower the dispersal the higher the genetic differentiation. Furthermore, the migration direction and rates are expected to show that organic farms function as a source for the conventional farm for the species in question, again depending on dispersal ability.

4) The effective population size, N_e , (the part of a population contributing with genes to the next generation) can be estimated from the three species because they are sampled twice. N_e determines the impact of genetic drift (e.i. the random assortment of genes that are passed on to the next generation, which again is determined by the population size) and consequently the loss of genetic diversity that the population suffers. A small N_e is expected to increase the probability that a population goes extinct (Frankham 1995, Frankham et al. 2002). N_e can be estimated using a temporal method when the species are sampled twice and comparing the genetic diversity between the two samples (Schribner et al. 1997,). It is expected that organic farming possess higher population sizes which will be reflected in a higher effective population size as well.

Sampling

Pterostichus spp.: WP 3 will collect 30 individuals from two localities within each system twice.

Field vole: WP5 will take samples from 30 trapped individuals from two localities within each system twice during the spring season.

Grey Partridge: DNA will be extracted from faeces from as many birds (> 20) as possible. This will be collected from winter- feeding sites where the partridges have been trained to feed, as well as directly from observing the positions of naturally feeding flocks.

Laboratory methods.

Ten to fifteen DNA-microsatellite markers developed for other species of *Pterostichus* and other ground beetles (Lagisz & Wolff 2004, Brouat et al. 2002) will be tested for the genetic analysis of the *Pterostichus spp.*, and the successful and polymorphic microsatellites will be chosen.

For the field vole 15 polymorphic DNA-microsatellite markers developed for other mouse species (Van de Zande et al. 2000, Ishibashi et al. 1999) will be used and for the grey partridge 20 polymorphic DNA-microsatellite markers, five species-specific (AY228562-AY28558 Ass. no. GENBANK) and 15 developed for other Phasianidae species (Crooijmans et al. 1997, Several Ass. no. in GENBANK for chicken) will be used to estimate the genetic parameters.

The genetic laboratory analysis will take place in the DNA-laboratory at NERI in Silkeborg.

The WP6 will include the Ph.D. student provided that ISOBIS supports the 2/3 of the student.

Deliverables:

- D 6.1 Scientific publication: Genetic dispersal rate and direction of the ground beetle, *Pterostichus spp.* Conventional versus organic farming.
- D 6.2 Scientific publication: Genetic dispersal rate and direction of the field vole *Microtus agrestis*. Conventional versus organic farming (Ph.D).
- D 6.3 Scientific publication: Genetic dispersal rate and direction of the grey partridge, *Perdix perdix*. Conventional versus organic farming (Ph.D).
- D 6.4 Scientific publication: Impact of dispersal ability on genetic differentiation and the estimated migration rates and directions in conventional versus organic farming (Ph.D).
- D 6.5 Report: The role of organic farms as genetic sources for species in the arable land.

Milestones:

- M 6.1 Testing of primers for the ground beetle, field vole and grey partridge and start of genetic analyses in the laboratory (start 01.09.07).
- M 6.2 Ph.D. start (01.08.07)
- M 6.3 Genetic analyses of the three species in the laboratory continued from the first sampling period and second sampling period (Ph.D. and technicians) (31.12.08).

- M 6.4 Genetic analyses of the grey partridge depending on sampling success the two last sampling periods in the laboratory (31.03.09).
- M 6.5 Data analyses of the genetic data and writing of papers (31.12.09).
- M 6.6 Writing papers and Ph.D. completed (31.07.10).
- M 6.7 Data analyses, development of migration model for the ground beetle, feeding data to WP7 and writing of scientific publications and report (31.12.10).

WP No.: 7 The role as refugia and biological sources: a synthesis

Start date or starting event: 01.01.2007							
Partner id.	NERI	CJT PNA LWA MBP BST	Museum of Natural History	TSJ	DIAS	TD	
Person-months per participant	11,8 VIP			1 VIP		1 VIP	
Total PM VIP:	13,8 VIP						

Objectives:

- to collate and integrate information from work packages 2-6 to form a synthesis of the role of organic farms as refugia, source habitats or islands of species diversity in the Danish agricultural landscape.
- to analyse the impact of increasing the proportion of organically farmed area on population size and distribution.
- to analyse the impact of positioning the organic farms, e.g. clumped or evenly dispersed in the landscape.
- to analyse the importance of intensive versus extensive organic farm management on the role of organic farms as refugia.
- to create a workable landscape wildlife index (LWI) for assessing the value of a landscape configuration of organic farms on the wildlife content of the landscape.

Description of work:

Methods

This work package will utilise two main tools, the ALMaSS modelling system and GIS-based analyses and relies on drawing together the data from the other work packages (Figure 1). Data from the other work packages will be used to a) support the modelling of species (genetics from WP6, small mammals from WP5); b) to provide the framework to classify organic farm types and to determine their distribution and area (from WP2); c) to provide input data for the development of species diversity indices and improvement of organic crop/insect relationships (WP 3 and 4).

The ALMaSS system will be used to carry out a set of scenario analyses to evaluate the impact of the four factors above on a range of species. The system and species models required for this are already developed (Topping et al 2003ab; Bilde & Topping, 2004; Topping & Odderskær, 2004; Jepsen & Topping, 2004; Thorbek & Topping, 2005), therefore only relatively small modifications to incorporate organic farming managements need to be added to the system. In order to standardise the output a method for evaluating consequences of management scenarios (Jepsen et al, 2005) will be utilised and implemented as the starting point for a landscape wildlife index for the suitability of the landscape for these indicator species.

Species to be used for this index would be: Partridge (*Perdix perdix*), Hare (*Lepus capensis*), Skylark (*Alauda arvensis*), Field Vole (*Microtus agrestis*), a linyphiid spider (*Erigone atra*), and a carabid beetle (*Bembidion lampros*). Scenarios would also take landscape structural variability and the form of conventional agriculture into account in the scenarios. The total number of scenarios will be large (maximally 216 scenarios x total number of indicator species, Table WP7, although not all combinations can be used).

As part of the PhD study in WP6, the field vole will also be analysed in terms of its population genetics, since ALMaSS already has a population genetics component for this species (Topping et al, 2003b; Pertoldi & Topping, 2004). The output from WP6 will thus be used as a data input to this modelling work. The impact of the different landscape configurations will therefore be analysed to determine the impact on the population genetics of field voles.

Once created the landscape wildlife index will provide a tool for weighting stakeholder interest in wildlife together with the contribution of organic farming. Hence hunting interest will prioritise the game species, whilst recreational will prioritise others, and farming will prioritise the beneficial arthropods. This will provide a functional tool for assessing the impact of different organic farm types for a range of interest groups. Examples of the method of application of this technique will be included in the report from this WP.

Landscape Type	Organic Farm Distribution	Organic Farm Area	Intensiveness of management	Conventional Agriculture Form
Typical Danish	Even	Current	100% Intensive	Danish mean conditions
Heterogenous	Aggregated	2x	50% Extensive	100% Arable/Pig
Homogenous		10x	100% Extensive	100% Dairy
		100%		

Table WP7 showing the basic factors to be varied for each scenario.

Deliverables:

- D7.1 Report 1: Evaluation of the role of organic farming in the landscape for the range of indicator species chosen.
- D7.2 Scientific publication: Evaluating the interaction between farming management, and organic farm structure and the population and spatial dynamics of the species modelled in ALMaSS.
- D7.3 Scientific publication on modelling the impact of landscape configuration of organic farms on the population genetics of field voles (PhD)
- D7.4 Scientific publication on the development and application of the landscape index for wildlife.

Milestones:

- M 7.1 Scenario inputs data (configurations) completed (30.06.2008)
- M 7.2 ALMaSS Scenarios completed (31.12.2009)
- M 7.3 Development and application of landscape index complete (30.06.2010)
- M 7.4 Report (D7.1) (Project conclusion – 31.12.2010)

A.3 Project resources and budget overview

The National Environmental Research Institute (NERI) is a research institute under the Ministry of Environment. The main objectives of NERI are to advise the Ministry on nature and environmentally related issues. The focus of Department of Wildlife Ecology and Biodiversity is research in population dynamics of wildlife and game and conservation of biodiversity. Department of Terrestrial Ecology (TERI) undertakes research to describe the effects of anthropogenic disturbances on the terrestrial ecosystems.

The Natural History, Museum, Aarhus (NHM) is an abm-institution under The Ministry of Cultural affairs. The main objective of the museum is to conduct research within the field of natural history and to disseminate the results of this research to the public, e.g. by exhibitions, publications, school service and other activities. The research is focused on landscape ecology, freshwater ecology, bioacoustics, soil ecology, taxonomy and Danish faunistics.

The Danish Institute of Agricultural Sciences (DIAS) is a research institute under the Ministry of Food, Agriculture and Fisheries. DIAS is one of the largest research institutions in Denmark. Department of Agroecology focuses its research on the interaction between land use and the environment, and have extensive knowledge on organic farming systems. The department has state-of-the-art GIS and remote sensing facilities, and collections of national farm databases and GIS- and satellite image data from the 1970'es until today.

Dr. Liselotte Wesley Andersen is a senior scientist at DMU-VIBI with extensive expertise in empirical population genetics and the application of this in the use of management of threatened species. She has many years' laboratory experience and has recently build the DNA-lab at NERI.

Dr. Chris Topping is a senior scientist at DMU-VIBI with extensive expertise in construction of landscape-scale simulation systems – genetic, toxicological, ecological, and management aspects. Population dynamics of polyphagous predators. Invertebrate sampling methodology. Current: Population dynamics of European brown hare (*Lepus capensis*) and partridge (*Perdix perdix*). Impacts of mechanical weeding on skylarks.

Dr. Beate Strandberg is a senior scientist at DMU-TERI with extensive experiences on biodiversity in agricultural, natural and seminatural ecosystems, plant-plant interactions, competition, invasive plants, effects of agricultural practices (pesticides, GMPs) and risk assessment of genetically modified plants (GMP). Responsible for WP 4.

Dr. Marianne Bruus Pedersen is a senior scientist at DMU-TERI with extensive experiences on food-web effects of xenobiotics, including effects of pesticides on agricultural biodiversity as well as risk assessment of pesticides, metals and GMOs. Participant in the FØJO II project Nature Quality in Organic Farming. Responsible for WP 3.

Christian Damgaard (Dr. Scient.) ia a Senior Scientist at the Department of Terrestrial Ecology, NERI. He has experience in population ecological and population genetic modelling. Recently, his research has been focussed on plant-plant interactions, where he has concentrated on developing empirical ecological models with biologically interpretable parameters, which can be applied to ecological data using advanced statistical methodology

Dr. Thomas Secher Jensen is a former associate professor at Aarhus University and has supervised 5 ph.d.- and approx. 50 M.Sc.- students. He has extensive expertise in the ecology and island bio-geography.

Dr. Tommy Dalgaard has research experience from several Danish and international, inter-disciplinary research projects regarding multifunctional agriculture, GIS-scenario analyses, upscaling methodologies, organic farming and energy use/production. Is currently WP leader in the EU-FP6 Strategic Research Project on '*Instruments for impact assessment of multifunctional agriculture*'. (www.mea-scope.org) (2004-2007), & project leader for DIAS' part of EU-FP6 Integrated Project on '*Sustainability Impact Assessment of Multifunctional Land Use in European Regions*'. (www.sensor-ip.org) (2005-2008).

Table for VIP person month allocated on WP's and partners

Partner WP	1 VIBI (NERI)	2 TERI (NERI)	3 NM	4 DJF	Total
WP1	3				3
WP2				7,25	7,25
WP3		7,75			7,75
WP4		3,30			3,30
WP5			18,5		18,5
WP6	22,9	3,5			26,4
WP7	9,8	2	1	1	13,8
Total	35,7	16,55	19,5	8,25	80

Table for breakdown of total budget on partners and different cost categories (DKK)

Participating institution	Responsible scientist	Salaries		Equip- ment	Operatio nal expenses	Total budget DKK (+20% overhead)
		Acade-mic	Techn. adm.			
NERI	LWA BST MBP CD CJT	2.389.533	1.333.921		337.287	4.872.888
Museum of Natural History, Aarhus (NM)	TSJ TSH Tech.	822.251	99.948		190.000	1.334.638
Danish Institute of Agricultural Sciences, Dept. of Agroecology	TD	477.725	93.275	16.000	92.800	779.760
						6.987.286

A.4. Dissemination of scientific results

Experienced senior researchers, researchers and technicians, will perform the work in the project. We have incorporated the education of a Ph.D. student within the framework of the project provided that ISOBIS find the 2/3 of the student, which they have expressed interest in. The research team has a large international scientific network on related issues. The communication of results will be performed through:

1. publication of scientific papers in peer-reviewed international journals and on international congresses and workshops.

2. DARCOF e-news
3. popular Danish written publications
4. a DARCOF report, if the DARCOF secretariat finds this appropriate
5. participation in the yearly Danish Organic Farming Congress (Dansk Økologikongres).
6. presentations at conferences and meetings within the European Landscape Tomorrow research network, and integrated with the ongoing research in the EU projects of MEA-scope, SENSOR and NitroEurope (see point A5).

A.5. Scientific collaborations

DIAS is a member of the The Landscape Tomorrow research network (www.landscape-tomorrow.org), which links 25 institutes from 17 European countries who have a common interest in the multifunctionality of rural landscapes. The main roles of Landscape Tomorrow are to organise conferences and promote communication between researchers and the EU Commission.

DIAS co-ordinates a workpackage and participates in the co-ordination of an EU Strategic research project on Multifunctional agriculture: MEA-scope ("Micro-economic instruments for impact assessment of multifunctional agriculture to implement the Model of European Agriculture", www.meascope.org, contract no. SSPE-CT-2004-501516 STREP MEA-Scope). MEA-scope is co-ordinated by Centre for Agricultural Landscape and Land Use Research (ZALF) Germany, and has 11 partners and aims to link and test models of the economic and environmental impacts of agriculture at the landscape scale. Also DIAS participate in the EU Integrated Project SENSOR (www.sensor-ip.org, contract no. 003874 (GOCE) - SENSOR), and co-ordinates the WP4 landscape and GIS-activities in the NitroEurope Integrated Project application (www.neu.ceh.ac.uk).

Together with other universities and sector research institutions, DIAS and NERI participate in a research network on Multifunctional farming (2005-2006) funded by the Danish Research Councils. The research network is co-ordinated by Associate Professor Henrik Vejre, Royal Veterinary and Agr. University of Denmark.

NERI is a member of the EU-financed network "ALTER-Net" which focuses on "Long-term Biodiversity, Ecosystem and Awareness Research". The ALTER-net (www.alter-net.info) includes 25 partners from 17 European countries. Through this network NERI participates in the EU-application DECODE a project dealing with biodiversity in agricultural countryside.

NERI- Dept. of Terrestrial Ecology participate in the EU-proposal for the IP (integrated project) Development of a Concept of Dynamic Ecosystems (DECODE) for the call SUSTDEV-2004-3.III.2.1 Sub-Priority 6.3 Biodiversity and Ecosystems. The proposal has gone successfully through the first evaluation and the final evaluation is on going.

Concerning WPs 3 and 4 the present project will be co-ordinated with and benefit from the results obtained in the project: Herbicide tolerant GM-crops: Long-term effects on flora and fauna in field and field margins (2004-2007) financed by The Pesticide Research Programme (contact: Beate Strandberg, DMU-TERI).

The described projects in WP6 and 7 will link directly with NERI, Department of Wildlife Ecology and Biodiversity's Hunting License funded project "Markvildtets vilkår i

agerlandskabet med fokus på hare og agerhøne" which runs until December 2008 and investigates the causes of declines over the last 50 years in partridges. Partridge expertise will be obtained from this project, and common study areas will be used to maximise sampling efficiency and knowledge of the population structure of partridges.

NHM has been a partner in the Føjo I, Føjo II and Føjo IV-projects, the Strategic Environmental Project "Foranderlige landskaber", and Arealforvaltningsprojektet ARLAS. The museum participates in the EU funded project Vulcan, Vulnerability assessments of European shrubland under climatic changes".

NHM is a partner of Castex; an EU funded exhibition co-operative.

A.7 References

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A.8 Curriculum vitae

Curriculum Vitae for

Liselotte Wesley Andersen

Born: 13-11-57

Civil status: Married, two children

Education:

1985: Cand. Scient. in Biology from University of Aarhus, Department of Ecology and Genetics, Denmark.

1990 : Ph.D degree from University of Aarhus, Dept. of Ecology and Genetics, Denmark, with the title:
"The population structure and sex determination of the long-finned pilot whale and the harbour porpoise".

Employment:

1989-1993 : Associated professor in Biology at the Institute of Natural Sciences, University of Faroe Islands.

2000- : Senior Scientist in Population Genetics, National Environmental Research Institute, Dept. of Wildlife Ecology and Biodiversity, DK.

Projects financed by external funding and conducted at the University of Aarhus, Danish Institute of Fisheries Research and Danish Institute of Agricultural Sciences:

1986-1987 : The population structure of the long-finned pilot whale off the Faroe Islands.

1988-1989 : The population structure of the long-finned pilot whale and the harbour porpoise analysed by means of genetic variation.

1993-1994 : Application of molecular genetical and biochemical methods in the analysis of the population structure and social structure of the harbour porpoise and the long-finned pilot whale.

1995-1996 : Population genetic analysis of British and Danish harbour porpoises based on DNA-microsatellites.

: Population genetic analysis of the Atlantic walrus based on DNA-microsatellites and mtDNA variation.

1997-1998 : The population structure of the harbour porpoise analysed by DNA-microsatellites as a part of an EU-funded project (BYCARE).

: The population structure of the West Greenland walrus.

1999-2000 : The population structure of the North Atlantic minke whale.

Teaching activities:

1989-1993 : Taught first years Cytology, Genetics, Molecular Biology and Evolution at the University of the Faroe Islands.

2002-2004 : Supervisor for four master students.

Referee:

Canadian Journal of Zoology, Hereditas, Molecular Ecology, Journal of Cetacean Research and Management, North Atlantic Marine Mammal Commission, Conservation Genetics, Royal Society's journal Biology Letters, Norwegian Research Council, Marine Biology.

Congresses, Symposiums and meetings:

Participated in 22 different meetings, congresses and symposium from 1985 to 2004 with oral presentations or posters. Invited key-note speaker and chairman at the symposium conducted by the North Atlantic Marine Mammal Commission in 1999.

International refereed publications and reports.

First author or only author on 21 publications and reports, co-author on 7.

Andersen, L.W., Born, E.W., Gjertz I., Wiig, Ø., Holm L.E., Bendixen C. 1998: Population structure and gene flow of the Atlantic walrus, *Odobenus rosmarus rosmarus*, in the eastern Atlantic Arctic based on mitochondrial DNA and microsatellite variation. *Molecular Ecology* 7: 1323-1336.

Andersen, L.W and Born, E.W. 2000 Indications of two genetically different populations of Atlantic walrus (*Odobenus rosmarus rosmarus*) in West and Northwest. *Canadian Journal of Zoology* 78: 1999-2009.

Andersen, L.W, Ruzzante, D., Walton, M., Lockyer, C., Berggren, P. and Bjørge, A. 2001. Conservation genetics of the harbour porpoise populations in eastern and central North Atlantic. *Conservation Genetic* 2: 309-324.

Born, E.W., Andersen, L.W., Gjertz, I., Wiig, Ø. 2001. A review of Phylogenetic relationships of sub-populations of Atlantic walrus (*Odobenus rosmarus rosmarus*) east and west of Greenland. *Polar Biology* 24: 713-718.

Andersen, L.W. 2003. Harbour porpoises (*Phocoena phocoena*) in North Atlantic: Distribution and genetic population structure. In *NAMMCO Scientific Publications, Volume 5* (Eds.) Haug, T., Desportes, G., Víkingsson, G.A., Witting, L., Pike, D., Tromsø: 11-29.

Andersen, L.W., Born, E.W., Dietz, R., Haug, T., Øien, N. and Bendixen, C. 2003. Genetic population structure of minke whales (*Balaenoptera acutorostrata*) from Greenland, the North East Atlantic and the North Sea probably reflect different ecological regions. *Marine Ecology progress Series* 247: 263-280.

Bloch, D., Heide-Jørgensen, M.P., Stefansson, E., Mikkelsen, B., Ofstad, L.H., Dietz, R. & Andersen, L.W. 2003. Short-term movements of long-finned pilot whales *Globicephala melas* around the Faroe Islands. - *Wildlife Biology* 9(1): 47-58.

Andersen, L.W., Fog, K., Damgaard, C. 2004. Habitat fragmentation causes bottlenecks and inbreeding in the European tree frog (*Hyla arborea*). *Proc. R. Soc. Lond. B* vol 271(1545): 1293-1302.

Volunteer: Chairman of the Danish Tuberos Sclerosis Association since 1999.

SHORT CV FOR CHRISTOPHER JOHN TOPPING

Present Position:

Senior Research Scientist, NERI, Department of Wildlife Ecology and Biodiversity, Kalø, Grenåvej 14, DK-8410 Rønne, Denmark Tel: +45 8920 1700 Fax: +45 8920 1515 e-mail: cjt@dmu.dk

Date of birth: 19/09/1964

Education:

PhD: 'Pitfall trapping and community analysis of grassland spiders' awarded June 1990. University of Newcastle upon Tyne

BSc in Agricultural Zoology, 1st Class Honours, 1986, University of Newcastle upon Tyne. Awards: Winner of the George Heslop Harrison prize for the most outstanding entomologist 1986.

Previous Positions:

June 1993 - October 1995, Invertebrate Ecologist, Scottish Agricultural College, 581 King Street, Aberdeen AB9 1UD Scotland

January 1990 - May 1993, Higher Scientific Officer, Horticulture Research International, Worthing Road, Littlehampton, BN17 6LP, England

Research Areas:

Construction of landscape-scale simulation systems – genetic, toxicological, ecological, and management aspects. Population dynamics of polyphagous predators. Invertebrate sampling methodology. Current: Population dynamics of European brown hare (*Lepus capensis*) and partridge (*Perdix perdix*). Impacts of mechanical weeding on skylarks.

Project Leadership/Funding:

1992, OECD fellowship under the Co-operative Project for Biological Resource Management programme. Work executed in Palmerston North, New Zealand.

1993-1995, Leverhulme Trust 2-year post-doc funding on the population dynamics of *Lepthyphantes tenuis*.

1994-1997, Scottish Office for Agriculture and Fisheries ROAME Modelling the spatial dynamics of spiders in agricultural land. 3 yrs SOAFD funded.

1994-1997, SAC Research Assistantship on the population genetics of spiders.

1998-2000 An integrated landscape model 3 years funded from SMP2.

1998-2001 ALMaSS: Biodiversity and beneficials in organic farms, funded by Structurdirektoratet.

1998-2002 The Animal, Landscape & Man Simulation System (ALMaSS) funded from 'Jordbrugerens som landskabsforvalter' programme.

1999-2000 SMP2 funded sub-project: ALMaSS: Developing mammal models.

2000-2004 Monitoring the effects of pesticides on flora & fauna. Miljøstyrelsen.

2001-2003 Syngenta funded project: Developing strategies to minimise the effects of pesticide applications on linyphiid spiders through scenario modelling.

2001-2004 Spatial dynamics of beetles and spiders w.r.t changes in organic farm areas and management FØJO funded.

Other Information:

Initiator, co-ordinator and lead programmer for the ALMaSS risk assessment simulation model framework (see <http://www.almass.dk>).

Publications for C. J. Topping (2000-2004)

Internationally refereed articles

1. Warren, JM. & Topping C. J. 2001. Trait evolution in an individual-based model of herbaceous vegetation. *Evolutionary Ecology* 15: 15-35
2. Thorbek, P., Topping, C. J. & Sunderland, K. D. 2002. Validation of an inexpensive, simple method for monitoring aerial activity of spiders. *Journal of Arachnology* 30: 57-64
3. Topping C.J., Hansen, T.S., Jensen, T.S., Jepsen, J.U., Nikolajsen, F. and Odderskær, P. 2003. ALMaSS, an agent-based model for animals in temperate European landscapes. *Ecological Modelling* 167: 65-82
4. Topping C.J., Østergaard, S., Pertoldi, C.B. & Bach, L.A. 2003. Modelling the loss of genetic diversity in vole populations in a spatially and temporally varying environment. *Annales Zoologici Fennici* (40): 255-267
5. Topping C.J. & Odderskær, P. 2004. Modeling the influence of temporal and spatial factors on the assessment of impacts of pesticides on skylarks. *Environmental Toxicology & Chemistry* 23, 509-520.
6. Bilde T. and Topping, C.J. 2004. Life-history traits interact with landscape composition to influence population dynamics of a terrestrial arthropod: a simulation study. *EcoScience* 11(1): 64-73
7. Thorbek, P., Sunderland, K.D. & Topping, C.J. Eggsac development rates and phenology of agrobiont linyphiid spiders in relations to temperature: prediction, validation and implications for biocontrol potential. *Entomologia Experimentalis et Applicata* 109: 89-100.
8. Thorbek, P., Sunderland, K.D. & Topping, C.J. Reproductive biology of agrobiont linyphiid spiders in relation to habitat, season and biocontrol potential. *Biological Control* 30: 193-202
9. Pertoldi, C. & Topping, C.J. 2004. The use of Agent-based modelling of genetics in conservation genetics studies. *Journal of Nature Conservation* 12: 111-120.
10. Pertoldi, C. & Topping, C.J. 2004. Impact assessment predicted by means of genetic agent-based modelling. *Critical Reviews in Ecotoxicology* 34 (6): 487-498.
11. Jepsen, J.U. & Topping, C.J. 2004. Modelling roe deer (*Capreolus capreolus*) in a gradient of forest fragmentation: behavioural plasticity and choice of cover. *Canadian Journal of Zoology* 82: 1528-1541

12. Warren, J. & Topping C. J. 2004. A trait specific model of competition in a spatially structured plant Community. *Ecological Modelling* 180: 477-485
13. Jepsen, J.U. Vos, C.C., Topping, C.J., Baveco, H. Verboom, J.V. 2005. Effects of landscape heterogeneity and dynamics on estimates of corridor efficiency - a simulation approach using multiple spatial models. *Ecological Modelling* 181:445-459.
14. Jepsen, J.U., Topping, C.J., Odderskær, P. and Andersen, P.N. 2005. Evaluating consequences of land-use strategies on wildlife populations using multiple species predictive scenarios. *Agriculture Ecosystems & Environment* 105 (4): 581-594.
15. Thorbek, P. & Topping, C.J. 2005. The influence of landscape diversity and heterogeneity on spatial dynamics of agrobiont linyphiid spiders: an individual-based model. *BioControl* (in press)
16. Topping, C. J., Sibly, R.M., Akcakaya, H.R., Smith, G.C., & Crocker, D.R. 2005 Risk assessment of UK skylark populations using life-history and individual-based landscape models. *Ecotoxicology* (in press).
17. Sibly, R.M., Akcakaya, H.R., Topping, C. J., O'Connor, R.J. 2005. Population-level assessment of risks of pesticides to birds and mammals in the UK. *Ecotoxicology* (in press).

CV for Beate Strandberg

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Working address: National Environmental Research Institute (NERI), Dep. Terrestrial Ecology, Vejlshøjvej 25, P.O.Box 314, DK-8600 Silkeborg
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Education: Institution: Department of Plant Ecology, Botanical Institute, University of Copenhagen
Year: 1996
Degree: Ph.D. (Vegetation recovery at anthropogenically disturbed sites in Greenland. With emphasis on means of revegetation)
Institution: Department of Plant Ecology, Botanical Institute, University of Copenhagen
Year: 1989
Degree: Cand. scient. (Cæsiium i græsningsfødekæder)

Key qualifications: extensive experiences on biodiversity in agricultural, natural and seminatural ecosystems, plant-plant interactions, competition, invasive plants, effects of agricultural practices (pesticides, GMPs) and risk assessment of genetically modified plants (GMP).

Refereed Papers (2000-2005):

1. Tybirk, K., Nilsson, M.C., Michelsen, A., Kristensen, H.L., Shevtsova, A., Strandberg M.T. Johansson, M., Nielsen, K.E., Riis-Nielsen, T., Strandberg, B., Johnsen, I. 2000. Nordic Empetrum Dominated Ecosystems: Function and Susceptibility to Environmental Changes. *AMBIO* 29(2), 90-97.
2. Forbes, B.C., Ebersole, J.J. & Strandberg, B. 2001. Anthropogenic Disturbance and Patch Dynamics in Circumpolar Arctic Ecosystems: Implication for Conservation. *Conservation Biology* 15(4) 954-969.
3. Strandberg, B. Svejgaard Jensen, J. 2001 Environmental Risk Assessment of Genetically Modified Trees in Denmark. Paper presented at the OECD Workshop 13.-15. Sep. 1999 Trondheim, Environmental considerations - genetically modified trees.
4. Erneberg M., Strandberg B. & Jensen B. D. (2003). Susceptibility of a plant invader to a pathogenic fungus: an experimental study of *Heracleum mantegazzianum* (Giant Hogweed) and *Sclerotinia sclerotiorum*. Pp. 355-372 in: L.E. Child, J.H. Brock, G. Brundu, K. Prach, P. Pysek, P.M. Wade and M. Williamson (eds.) *Plant Invasions: Ecological Threats and Management Solutions*. Backhuys Publishers, Leiden.
5. Madsen, K.H., Thomsen, J.N., Strandberg, B., Sandøe, P. (2004) Ethical perspectives of herbicide resistant sugar beet. *The IIRB Advances on herbicide resistant sugar beet*, pp 278-288.
6. Strandberg, B. 2004. Review – Responses of farmland wildlife to genetically modified herbicide tolerant crops. *AGBiotechNet*, 6, ABN 122, pp 1-7.
7. Strandberg, B., Bruus Pedersen, M., Elmegaard, N. (2005) Weed and arthropod populations in conventional and genetically modified herbicide tolerant fodder beet fields. *Agriculture, Ecosystems and Environment* 105, 243-253.
8. Strandberg, B., Kristiansen, S.M., Tybirk, K., (2005) Dynamic oak-scrub to forest succession: effects of management on understorey vegetation, humus forms and soil. *Forest Ecology and Management* (in press)
9. Strandberg, B. Axelsen, J.A., Bruus Pedersen, M., Jensen, J., Attrill, M. (2005) The impact of a copper gradient on plant community structure. *Environmental Toxicology and Chemistry* (in press)
10. Graae, B.J., Strandberg, B., Bastholm, G., Fischer, E.A. Seed Dispersal, Germination and Seedling Establishment in Arctic Vegetation. Manus Submitted to *Seed Ecology*. October 2004
11. Strandberg, B., Strandberg, M.T. Methods for evaluation of grassland invasibility, Manus submitted to *Weed Science* Jan. 2005.
12. Maraldo, K., Christensen, B., Strandberg, B., Holmstrup, M. Effects of copper on enchytraeids in the field under differing soil moisture regimes. Manus submitted, Jan. 2005.
13. Jensen, B.D., Hauser, T.P., Finckh, M., Strandberg, B., Munk, L. Susceptibility of a wild carrot (*Daucus carota* ssp. *carota*) to *Sclerotinia sclerotiorum*. Manus submitted to *Plant Pathology* Feb. 2005.

Other publications:

1. Strandberg, B. & Pedersen, M.B. 2000. Growing transgenic Roundup-tolerant fodder beet has the potential to give more weeds in the field. Presentation at the Third SETAC World Congress, Brighton, UK, 21-25 May 2000.
2. Bruus Pedersen, M., Strandberg, B. 2000. Roundup-tolerante foderroer kan give mere ukrudt og dermed måske grundlag for flere insekter i markerne. http://www.sns.dk/natur/bioteknologi/roundup_art.htm
3. Strandberg, B., Hendriksen, N.B., Kjellsson, G., Damgaard, C.F., 2001. Impact of Genetically Modified Organisms on the Environment. Mapping of Risk. Report requested by: European Commission Directorate General Joint Research Centre, Institute for prospective Technological Studio, Seville, Spain. Project No. K10230/11/99 148pp.
4. Strandberg, B. Axelsen, J.A. 2001. Naturkonsekvenser af landbrugets anvendelse af GMO'er. Pp.100-107 i: *Naturrådet 2001. Invasive arter og GMO'er – nye trusler mod naturen*. Temarapport nr. 1.
5. Strandberg, B., Bruus Pedersen, 2002. Biodiversity in Glyphosate Tolerant Fodder Beet Fields – Timing of herbicide application. NERI Technical report No. 410. <http://technical-reports.dmu.dk>
6. Strandberg, B., Kjær, C., Hindar, K., Tømmerås, B.Å., 2002. Environmental Risk Assessment of Genetically Modified Organisms (GMOs). Identification of data needs. *NORDTEST Rapport*. 66 pp.
7. Strandberg, B., Bruus Pedersen, M., Elmegaard, N. 2002. Glyphosate tolerant beets: perspectives for farmer and the environment. 19th Danish Plant Protection Conference, Weeds, pests and diseases. DJF-rapport Nr. 64, 167-180.

C.V. of Marianne Bruus Pedersen

- Born:** April 18 1962
- Education:** MSc in biology at Aarhus University, Department of Zoology, 1991
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- Address:** National Environmental Research Institute (DMU)
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- Key qualifications** Senior scientist I with extensive experiences on food-web effects of xenobiotics, including effects of pesticides on agricultural biodiversity as well as risk assessment of pesticides, metals and GMOs. Participant in the FØJO II project Nature Quality in Organic Farming.

Publications the latest five years

Scientific papers

- Bruus Pedersen, M., Kjær, C. & Elmegaard, N. (2000). Toxicity and bioavailability of copper to black bindweed, *Fallopia convolvulus*, in relation to bioaccumulation and the age of soil contamination. *Archives of Environmental Contamination & Toxicology* 39: 431-439.
- Bruus Pedersen, M., Van Gestel, C.A.M. & Elmegaard, N. (2000). Effects of copper on the reproduction of two collembolan species exposed through soil, food and water. *Environmental Toxicology and Chemistry* 19: 2579-2588.
- Bruus Pedersen, M. & Van Gestel, C.A.M. (2001). Toxicity of copper to the collembolan *Folsomia fimetaria* in relation to the age of soil contamination. *Ecotoxicology and Environmental Safety* 49, 54-59.
- Aude, E., Tybirk, K. and Bruus Pedersen, M. (2003). Vegetation diversity of conventional and organic hedgerows in Denmark. *Agriculture, Ecosystem & Environment* 99 (1-3): 135-147.
- Strandberg, B., Bruus Pedersen, M. and Elmegaard, N. (2005). Weed and invertebrate populations in conventional and genetically modified herbicide-tolerant beets. *Agriculture, Ecosystems and Environment* 105, pp. 243-253.

Reports and report papers

- Bruus Pedersen, M., Strandberg, B. 2000. Roundup-tolerante foderroer kan give mere ukrudt og dermed måske grundlag for flere insekter i markerne. Project paper for the Danish EPA, <http://www.sns.dk/natur/bioteknologi/genartikler.htm>.
- Kjær, C., Nielsen, J.K., Elmegaard, N., Bruus Pedersen, M., Damgaard, C.F. 2001. Phytochemical responses to herbicide exposure and effects on herbivorous insects. Report to the Danish EPA no. 55 2001.
- Elmegaard, N., Bruus Pedersen, M. 2001. Flora and Fauna in Roundup Tolerant Fodder Beet Fields. National Environmental Research Institute. 40 pp. NERI Technical Report No. 349.
- Strandberg, B & Bruus Pedersen, M. 2002. Biodiversity in Glyphosate Tolerant Fodder Beet Fields. Timing of herbicide application. National Environmental Research Institute, Silkeborg, Denmark. 36 pp. – NERI Technical Report No. 410. <http://technical-reports.dmu.dk>.
- Bruus Pedersen, M, Aude, E & Tybirk, K. 2004. Adskillelse af effekter af herbicider og kvælstof på vegetation og leddyr i hegn og engvegetation. Pesticide Research from the Danish EPA, no. 87 2004.
- Topping, CJ, Bruus Pedersen, M, Axelsen, JA, Tybirk, K, Odderskær, P. In press. Monitoring and modelling effects of reduced pesticide usage. NERI Technical Report.

Curriculum vitae for Thomas Secher Jensen

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Uddannelse:

1966: Student fra Århus Katedralskole

1966-68: Biologistudie Århus Universitet

1968-71: Biologistudie Københavns Universitet

1971-75: Konferensstudie Århus Universitet. Mag.scient i økologi marts 1975.

1978-80: Licentiatstudie Århus Universitet. Lic.scient. i biologi april 1982.

Ansættelser:

1975-76: Århus Amt, Fredningsplanudvalget

1976-77: Research Associate. Institute of Arctic Biology, University of Alaska, Fairbanks.

1977-80: Kandidatstipendiat. Institut for Zoologi og Zoofysiologi, Århus Universitet.

1980-82: Videnskabelig medarbejder. Jordbrugs- og Veterinærvidenskabelige Forskningsråd.

1982: Lektor-vikar. Institut for Zoologi og Zoofysiologi, Århus Universitet.

1983: Gæsteforsker. Institut für Forstzoologie der Universität Göttingen, Tyskland.

1984-88: Adjunkt. Institut for Zoologi og Zoofysiologi, Århus Universitet

1988-99: Lektor. Biologisk Institut. Århus Universitet.

1999- : Direktør. Naturhistorisk Museum. Århus.

Publikationer

Carlsen, M., Lodal, J., Leirs, H. & T. Secher Jensen (1999): The effect of predation risk on body weight in the field vole *Microtus agrestis*. *Oikos* 87.2: 277-285.

Jensen, T.S. (2000): De små pattedyr og de alt for store landskaber. I: *Aktører i landskabet* (red. P. Grau Møller) Odense.

Carlsen, M., Lodal, J., Leirs, H. & T.S. Jensen (2000): Effects of predation on temporary autumn populations of subadult *Clethrionomys glareolus* in forest clearings - *Z. Säugetierkunde* 65:100-109.

Jensen, T.S. & Hansen, T.S. 2001: Effekten af husdyrgræsning på småpattedyr. I: Pedersen, L.B., Buttenschøn, R. & Jensen, T.S. (red): *Græsning på ekstensivt drevne naturarealer – Effekter på stofkredsløb og naturindhold*. Park- og Landskabsserien nr. 34, Skov & Landskab, Hørsholm. Side 107-121.

Nordvig, K., J. Reddersen & T.S. Jensen (2001): Small mammal exploitation of upper vegetation strata in non-forest, mixed farmland habitats. - *Mamm. Biol.* 66: 129-134.

Jensen, T.S. & Baagøe, H.J. (2001): Udbredelse af de danske pattedyrarter - kortlægningsprojektet Dansk Pattedyratlas. - *Flora og Fauna* 107: 37-42.

Jensen, T.S., Laursen, J.T. & Hansen, T.S. (2001): Udbredelse af birkemus i Danmark indtil 2001. - *Flora og Fauna* 107: 101-106.

Schmidt, N.S., T.B. Berg & T.S. Jensen (2002): The influence of body mass on daily movement patterns and home ranges of the collared lemming (*Dicrostonyx groenlandicus*). - *Can. J. Zool.* 80:64-69.

Jensen, T.S. & Hansen, T.S. (2003): Biodiversitet af smågnavere i agerlandet. - *Flora og Fauna* 109: 9-21.

Hansen, T.S., Wedfeldt, R. & Jensen, T.S. (2003): Husmus (*Mus musculus*) habitatvalg på Anholt. *Flora og Fauna*.

Topping, C.J., Hansen, T.S., Jensen, T.S., Jepsen, J.U. & Odderskær, P. (2003): ALMaSS, an agent-based modelling system for animals in temperate European landscapes. - *Ecological Modelling*.

Større forskningsprojekter i de sidste seks år

Arealanvendelsesprogrammet: Jordbrugeren som arealforvalter

Strategisk Miljøforskningsprogram: Foranderlige landskaber

Dansk Pattedyratlas 2000-2005.

Curriculum vitae for Tine Sussi Hansen

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Uddannelse:

1997: Cand. scient. Aarhus Universitet, Biologisk Institut, Afd. Zoologi
1990: Student Nakskov Gymnasium

Erhverv:

2003->: Konsulent, Naturformidling og rådgivning.
2004: Naturvejleder ved Molslaboratoriet, Naturhistorisk Museum, Århus
2000-2003: Projektforsker ved Naturhistorisk Museum, Århus ved projektet: Dansk Pattedyratlas
1999-2000: Projektansat biolog ved Naturhistorisk Museum, Århus ved projekterne: i) Effekten af husdyrgræsning for småpattedyrfaunaen i hede-, overdrev-, og skovøkosystemer og ii) Landskabsstrukturens indflydelse på småpattedyrfaunaen.
1997-1998: Forskningsassistent/Akademisk medarbejder ved Aarhus Universitet, Afd. Zoologi ved projekterne
1997: Akademisk medarbejder ved Danmarks Miljøundersøgelser, Afd. Landskabsøkologi, Kalø.

Publikationer:

Hansen, T.S. & Jensen, T.S. 2003: Biodiversitet af danske småpattedyr i det åbne land. *Apodemus* 7: 13.
Hansen, T.S. & Jensen, T.S. 2003: Mapping of small rodents in the Atlas of Danish Mammals. *Apodemus* 7: 24.
Hansen, T.S. & Ujvári, M. 2003: Afslutning på projektet Dansk Pattedyratlas. *Gejrfuglen* 39(2): 20-21.
Hansen, T.S., Wedfeldt, R. & Jensen, T.S. 2003: Husmusens (*Mus musculus*) habitatvalg på Anholt. *Flora og Fauna* 109(3+4): 101-106.
Hessellund, K., Jensen, T.S. & Hansen, T.S. 2003: Identifikation af danske markmus – skillekarakterer for alm. markmus og sydmarkmus. *Apodemus* 7: 23.
Jensen, T.S. & Hansen, T.S. 2003: Biodiversitet og biotopfordeling af småpattedyr i det åbne land. *Flora og Fauna* 109(1): 9-21.
Jensen, T.S. & Hansen, T.S. 2003: Småpattedyr i kulturlandskabet – modeller og den virkelige verden. *Apodemus* 7: 14.
Topping, C.J., Hansen, T.S., Jensen, T.S., Jepsen, J.U., Nikolajsen, F. & Odderskær, P. 2003: ALMaSS, an agent-based model for animals in temperate European landscapes. *Ecological Modelling* 167: 65-82.
Ujvári, M., Hansen, T.S., Baagøe, H.J. & Jensen, T.S. 2003: Sikker viden om 90 arter af pattedyr: kortlægningen af danske pattedyr er ved at være færdig. *Dyr i natur og museum* 2: 20-23.
Jensen, T.S. & Hansen, T.S. 2001: Effekten af husdyrgræsning på småpattedyr. I: Pedersen, L.B., Buttenschøn, R. & Jensen, T.S. (red): Græsning på ekstensivt drevne naturarealer – Effekter på stofkredsløb og naturindhold. Park- og Landskabsserien nr. 34, Skov & Landskab, Hørsholm. Side 107-121.
Jensen, T.S., Hessellund, K. & Hansen, T.S. 2001: Identifikation af danske markmus. Rapport fra Naturhistorisk Museum, 32 sider.
Jensen, T.S., Laursen, J.T. & Hansen, T.S. 2001: Udbredelse af birkemus (*Sicista betulina*) i Danmark indtil 2001. *Flora og Fauna* 107 (2): 101-106.
Hansen, T.S. 1997: Småpattedyrs habitatvalg på braklagte og opdyrkede marker. Specialrapport, Aarhus Universitet, Biologisk Institut, Afd. Zoologi, 165 s.
Olesen, C.R., Andersen, A.H. & Hansen, T.S. 1997: Rådyr, mus og selvforyngelse af bøg ved naturnær skovdrift. Danmarks Miljøundersøgelser. 61 s. - Faglig rapport fra DMU, nr. 203.

CURRICULUM VITAE

Name, birth Tommy Dalgaard, born December 24, 1970
Education Ph.D. Agroecology. The Royal Veterinary & Agricultural University of Denmark (RVAU).
 M.Sc. Agroecology. RVAU, Dept. of Agricultural Sciences.
 B.Sc. Agricultural Politics. RVAU, Dept. for Economics and Natural Resources.

Employment Record

Year	Organisation	Position and Responsibilities
1996-	Danish Institute of Agricultural Sciences (DIAS)	Head of Research Unit, Dept. of Agroecology (2004-) Senior Scientist, Dept. of Agric. Systems (2002-2004) Scientist, Dept. of Land Use (1996-2002)
1996	National Inst. of Animal Sci.	Scientific Assistant, Section for Production Systems.
1993	Tureby-Køge Agr. extension	Agronomic Assistant. Field experiments.
1992	Royal Vet. & Agric. University of Denmark (RVAU)	Teacher in botany (1994) Teacher in chemistry (1992-1994)

Key qualifications for the project

TDA has research experience from several Danish and international, inter-disciplinary research projects regarding multifunctional agriculture, GIS-scenario analyses, upscaling methodologies, organic farming and energy use/production. Is currently WP leader in the EU-FP6 Strategic Research Project on 'Instruments for impact assessment of multifunctional agriculture'. (www.mea-scope.org) (2004-2007), & project leader for DIAS' part of EU-FP6 Integrated Project on 'Sustainability Impact Assessment of Multifunctional Land Use in European Regions'. (www.sensor-ip.org) (2005-2008). Is co-initiator of a research network on multifunctional farming funded by The Danish Research Council (SJVF) (2003-2005). Has been invited speaker in context of OECDs working party on organic farming, IPCC/USDA, The Danish Parliaments committee for Nature & Env., EUROSTAT, & EC- research projects, networks & centres of excellences.

Other activities

TDA has served as invited peer reviewer for a number of journals including *Journal of Environmental Quality*, *European Journal of Agronomy*, *Agriculture Ecosystems and Environment*, *Agricultural Systems*, *China Science Press*, *Journal of Agricultural Education and Extension*, *The ScientificWorld*, *Biological Agriculture and Horticulture*, *Environmental and Resource Economics*. He has coordinated reviews for int. seminar proceedings, and serves as reviewer for *The United Nation Millennium Ecosystem Assessment*. Appointed expert for the research syntheses' regarding organic farming and: 1) Groundwater protection, 2001. 2) Bioenergy, 2004. (www.darcof.dk). Appointed expert for The Danish Action Plan for the Aquatic Environment III (www.vmp3.dk) scientific expert groups on "P flows, losses and amendment measures" and on "Economic models of cost for reduction of nutrient losses" (2004). Approved short-term expert (STE) in the implementation of EU agricultural policies, The Czech Ministry of Agriculture (2004-2005).

Scientific publications – selected references

Has published more than 20 peer reviewed papers, 30 conference contributions and 25 research reports. Fx:

- Dalgaard T (2005) *Landscape Agroecology*. Book Review. *Agricultural Systems* (in press)
- Dalgaard T, Hutchings NJ and Porter JR (2003) *Agroecology, scaling and interdisciplinarity*. *Agriculture Ecosystems and Environment* 100 39-51. Review paper.
- Dalgaard T, Hutchings NJ, Hansen JF and Mikkelsen HE (2003) *Scenarios for multifunctional landscape development - interactions between agriculture, nature and economy*. In: Helmig K & Wiggering H (eds.) *Sustainable Development of Multifunctional Landscapes*. p. 247-256. Springer Verlag.
- Dalgaard T, Heidman T and Mogensen L (2002) *Potential N-losses in three scenarios for conversion to organic farming in a local area of Denmark*. *European Journal of Agronomy* 16: 207-21.
- Dalgaard T, Ryggestad H, Jensen JD and Larsen PE (2002) *Methods to map and simulate agricultural activity at the landscape scale*. *Danish Journal of Geography* 3: 29-39.
- Dalgaard T, Halberg N & Porter JR (2001) *A model for fossil energy use in Danish agriculture used to compare organic and conventional farming*. *Agriculture, Ecosystems & Environment* 87(1) 51-65.
- Dalgaard T, Halberg N & Kristensen IS (1998) *Can organic farming help to reduce N-losses? Experiences from Denmark*. *Nutrient Cycling in Agroecosystems* 52:277-287

Name *Peder Klith Bøcher*
Profession GIS, remote sensing
Date of birth April 14, 1965
Nationality Danish
Civil status Married, two children
Education MSc, PhD
Position Scientist

Academic training

- M.Sc. Institute of Biology, University of Aarhus, Denmark, 1996
- Ph.D. Faculty of Science, University of Aarhus, Denmark 2004

Employment record

1997 - 2000. Research assistant, Danish Institute of Agricultural Sciences

2000 - 2004. PhD-scholarship, University of Aarhus.

2004 - : Scientist, Danish Institute of Agricultural Sciences.

N Key Qualifications

Research experience in remote sensing with specific focus on the analysis of spatial variation.

Participation in a number of projects targeting resource management, both in Denmark and abroad.

Publications

Bøcher, P.K. and McCloy, K. R. Accepted Jan 2005. The Fundamentals of Average Local Variance (II): Detecting Regular Patterns Sampled with Optical Sensors. IEEE Transactions on Image Processing.

Bøcher, P. K. and McCloy, K. R. Accepted Jan 2005. The fundamentals of local variance (I): Detecting regular patterns. IEEE Transactions on Image Processing.

Olesen, J. E., Bøcher, P. K. and Jensen, T. 2000. Comparison of scales of climate and soil data for aggregating simulated yields of winter wheat in Denmark. Agriculture, Ecosystems & Environment, 82: 213 – 228..

umber of publications

International scientific publications:	3 publish/accept 3 submitted
Ph.D. theses:	1
Other scientific publications and reports:	9
Popular articles	1
Conference presentations	8

CURRICULUM VITAE
Mette Balslev Greve, B.Sc.
Danish Institute of Agricultural Sciences

Current position	GIS-coordinator and GIS Software Engineer, Danish Institute of Agricultural Sciences
Education:	- Aalborg University 1998- 2001 - Bachelor of Computer Science (Bachelor i Datalogi) Aarhus Business College 1995- 1996 - Higher commercial Diploma Course in Statistics, (HD) - Aarhus Business College 1992-1994 - Datamatician Diploma (Datamatiker)
Key Qualifications:	- Developing GIS applications, Design of Geodatamodels, - Incorporation scientific models into GIS
Membership of Professional Associations:	- Vice president of ESRI Usergroup Denmark - Member of GeoForum Denmark, Danish Society for Geographical Information

Synopsis:

Since 1994-present employed at Danish Institute of Agricultural Sciences as IS-coordinator and GIS Software Engineer, analysing, designing and programming GIS applications in GIS with a tight connection to databases.

Participation in relevant national and international projects:

- Chief Software Engineer (analysis, design and implementation) on
- Incorporating water balance model into GIS – draught problems as regards to climate, soil type and topography
 - Developing a system for detecting windbreaks using laser scanning
 - Developing an internet GIS-system showing the data at DIAS
 - Designing and implementing a system for detecting and storing transition zones between soil types.
 - CABS, a system for managing the area control and crop classification of the applications for EU subsidies.
 - A system for managing rotation of crops in an ecological research project
 - Internet applications for farmer information
 - A system used in the field combining the handling and storing of soil data while collecting GPS signals
 - A smaller expert system for predicting airway/lung infection epidemics in calves.
 - A system for modelling evaporation based on topography and solar radiation.
 - A method of representing transition zones in soil boundaries.
 - Numerous smaller programs and systems requested by the researchers at DIAS.

List of selected publications

- Greve, M. H. & Greve, M. B. 2004. Determining and Representing Width of Soil Boundaries using Electrical Conductivity and MultiGrid. Accepted for publication in Computers and Geosciences.
- Greve, M.H., Greve, M.B., 2003. GIS ved Danmarks JordbrugsForskning. Århus Universitet, 2003.
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