Danish Research Centre for
Organic Food and Farming

# Progress Report 2008 and Application for Continuation in 2009

for research funding under the research programme:

**Research in Organic Food and Farming**
International Research Co-operation and Organic Integrity
(DARCOF III 2005-2010)

Funded by the Ministry of Food, Agriculture and Fisheries
under the Finance and Appropriation Act, Sections 24.33.02.10

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## 1. Project title and acronym

**The role of Organic Farms as refugia for biodiversity**

**REFUGIA**

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## 2. Project journal number

3304-FOJO-05-08-01

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## 3. Project period (month, year)

**Start of project:** 01.01-2007
**End of project:** 31.12-2010

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## 4. Head of project

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## 7. Midterm description of the project, its results and progress, and application for continuation in 2009

### a. Project 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 (*Bembidion lamprus.*) 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. Modelling 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.

***Table A.1: Work package list (from application)***

| 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 | | | |

## B. Objectives and expected achievements

It is generally accepted that organic farming gives rise to higher species richness than conventional farming. Several papers describe the beneficial impact of organic farming on biodiversity. Arable flora, invertebrates, birds and mammals all benefit from organic farming in terms of improved species richness and /or increased abundance. However, very few Danish studies have been undertaken in the last 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 objectives of the present 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

## C. Midterm results and progress

### C.1 Description (summary) of main results and conclusions for each year

**WP1:** During 2007 a total of four meetings were held at the different institutions involved. The main agenda at each meeting was: Identification of focus-areas for the research-activities in WP3, 4, 5 and 6, progress of the different activities in the WP's according to milestones, website and information plan. The website was up and running, the first popular note describing the project aims was published, several articles were published in various media.
In 2008 a total of three meetings have been held focussing on the synergy between REFUGIA and the FØJOII project, managed by Vibeke Langer centred on the typology describing organic farms, the progress of the WP's related to milestones and the consequences of the delay in the start of the Ph.D.
A folder describing the project was prepared and presented at the ISOFAR conference in Italy, June 2008. The folder was furthermore translated into Danish.

**WP2:** Based on updated information from the general digital farm registers of Denmark (GLR/CHR) a preliminary organic farm typology has been defined. This farm typology is iteratively. Moreover, fields, biotopes and landscape elements have been digitized for the study landscape near Bjerringbro, and for all other farms where the REFUGIA field investigations takes place. The possible remote sensed images to be required for the structural diversity assessments have been reviewed. During the next half year we will require the images, to be combined with the field polygon databases at DJF-JPM. The geographical information about organic farming have also been used for a chapter in a "Vidensyntese-report" from ICROFS, and preliminary project results have been presented at conferences and I the form of popular

paper publications.

**WP3:** In 2007 organically grown cereal fields were sampled systematically in order to obtain data on crop, weed and arthropod biomass during the growth season for comparison with data for conventionally grown cereal fields. The initial data analysis indicates that weed biomass is higher in organically grown cereal fields, whereas that does not seem to be the case for arthropod biomass. In 2008 the main objective has been to study whether weed-rich areas of organically grown cereal fields support herbivorous insects.

**WP4:** Data on vegetation and flowering in hedgerows at conventional and organic farms showed the hedgerows at organic farms had significantly more species. Furthermore, the plants flowered for a longer period, flowered at a higher frequency and more flowers per plant in hedgerows at organic farms compared to conventional ones. However, the data also revealed that it took time for new species to establish in the hedgerows. A significant and positive relation was found between number of years since transition and number of species in the hedgerows.
When looking for hedgerows for the WP4-monitoring it was obvious that there was a larger turn over in management practice from organic management to conventional. A short period with organic growth not necessarily results in a significant and positive effect on hedgerow biodiversity. Finding a high turn over rate in farming practice highlighted the need for special incitements to get longer periods with organic management at the farms.

**WP5**: A total of 2751 small mammals were caught in traps. Without recaptures we registered 1966 individuals belonging to 12 species. The most common was the bank vole *Myodes glareolus* (670) followed by the common shrew *Sorex araneus* (526).
In the Bjerringbro area we caught significantly more bank voles in organic hedgerow compared to the conventional ones. In the grassland habitats (meadow and set a side fields) in the Bjerringbro area the number of field voles *Microtus agrestris*, harvest mice *Micromys minutus* and common shrew *Sorex araneus* were higher in the organic sites, and in the Kalø area the same was registered for the field vole.
In the cultivated fields the population densities were very low compared to the densities in hedgerows, grassland areas and small biotopes.
The small biotope study showed a strong relationship between small mammal densities and the size of the small biotope, and even with a tendency of higher densities in the organic small biotopes.
Overall there seems to be a positive effect of organic farms on small mammal populations. However a wide range of variables may have an influence as well (e.g. distance to other suitable habitats, width of the habitat). Therefore further data analysis of how the landscape structure affects the small mammal populations is needed.

**WP6:**In November 2007 the second 1/3 of the Ph.D. was granted by ISOBIS /AGSoS. The position was advertised through University of Aarhus, Denmark and on EvolDir on the internet in May 2008.
Five applications were received and the best qualified person with the highest marks was chosen which released the last 1/3 from the faculty of Natural Science, University of Aarhus. The person started 01/09-2008.

**Grey partridge**: During winter 2007/2008 40 faeces from grey partridge were collected at Kalø, representing the organic farming area and 22 faeces were sampled in the area close by

representing conventional farming area. DNA has been extracted from all and a total of 17 genetic markers (microsatellites) have been identified from grey partridge and other more closely related species. The markers are being optimised to work on the grey partridge faeces samples for further processing.

**Field vole**. During autumn 2007 and winter 2007/2008 162 field voles were sampled, representing both organic and conventional areas in Bjerringbro and at Kalø and Fussingø. DNA has been extracted and a total of 16 genetic markers (microsatellites) from the field vole and other nearby species have been identified and are further analysed for variation before processing further.

***Bembidion lamprus*.** In May 2008 30 pit-fall traps (representing 10 locations) were set along hedgerows at Kalø, to sample Bembidion. The pit-fall traps were placed along hedgerows near to conventional or organic fields as well as between organic/organic, organic/conventional and conventional/conventional fields. In the Bjerringbro area 42 pit-fall traps (representing 14 sampling locations) were set along hedgerows using identical sampling design. The exact sampling locations were marked using GPS in both areas. The traps were emptied 5 times in the Kalø area and 4 times in the Bjerringbro area. Additionally, the beetles were sampled manually twice in Bjerringbro and once at Kalø in August. This resulted in at least 30 beetles from 11 sampling locations from the Bjerringbro area and 9 sampling locations from the Kalø area which finished the first sampling year. DNA is being extracted in the DNA laboratory in Silkeborg at the moment.

**WP7**

No progress no planned activities for 2008, except those relying on M2.2 which is not yet complete.

## C.2 Fulfilment of deliverables and milestones

*(To be completed for each work package)*

Deliverables list (from application)
Deliverables list (from application)

| **Workpackage 1** | | | | | | |
|---|---|---|---|---|---|---|
| **Delive-rable No** | **Deliverable title** | **Lead scien-tist** | **Delivery date** | **Allo-cated scien-tific per-son moths** | **Type of deliv er-able** | **Fulfilled (ok) or devia-tions (d)*** |
| D1.1 | Annual status report including milestones from all WP's | LWA | 31.12.2007 | 0.5 | R | OK |
| D 1.2 | Final report of the results of the WP's | LWA (all) | 31.12.2010 | 1 | R | ok |
| | | | | | | |
| | | | | | | |

** Deviations are to be further discussed in D*

Milestones list (from application)

| **Workpackage 1** | | | |
|---|---|---|---|
| **Mileston No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or devia-tions (d)*** |
| M1.1 | Upstart of the project | 03.01.07 | ok |
| M1.2 | Annual co-ordination meeting | 31.08.07 | ok |
| | | | |
| | | | |
| | | | |

** Deviations are to be further discussed in D*

(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.).

| **Workpackage 2** | | | | | | |
|---|---|---|---|---|---|---|
| **Deliverable No** | **Deliverable title** | **Lead scientist** | **Delivery date** | **Allocated scientific person moths** | **Type of deliverable** | **Fulfilled (ok) or deviations (d)*** |
| D2.1 | A popular paper on the multifunctional role of organic agriculture in Denmark. | TDA | 31.09.2008 | 1.2 | P | Ok |
| D 2.2 | Web based maps over organic farming structure and development in Denmark | RLA | 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 | |
| | | | | | | |

** Deviations are to be further discussed in D*

Milestones list (from application)

| **Workpackage 2** | | | |
|---|---|---|---|
| **Milestone No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or deviations (d)*** |
| M2.2 | An organic farm typology ready for implementation in GIS | 01.04.08 | Ok/ d |
| M2.3 | Farm typology incl. information on organic/conventional farming coupled to field polygons in the GIS-landscapes, and delivered to WP7 | 06.06.09 | |
| M2.4 | National grid maps of farming structure development in Denmark ready. | 01.12.08 | |
| M2.5 | Remote sensed images ready for habitat diversity analysis of organic farms and fields | 31.03.09 | |
| | | | |

| **Workpackage 3** | | | | | |
|---|---|---|---|---|---|

| Deliverable No | Deliverable title | Lead scientist | Delivery date | Allocated scientific person moths | Type of deliverable | Fulfilled (ok) or deviations (d)* |
|---|---|---|---|---|---|---|
| D 3.1 | A scientific paper comparing the weed density and diversity in organic with the measurements from conventional farming from Topping et al. (unpubl.). | 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. (unpubl.). | 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 | |

** Deviations are to be further discussed in D*

Milestones list (from application)

| **Workpackage 3** | | | |
|---|---|---|---|
| **Milestone No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or deviations (d)*** |
| M 3.1 | Investigation farms selected | 31.03.07 | Ok |
| M 3.2 | Sampling programme planned in detail | 31.03.07 | Ok |
| M 3.3 | Sampling programme 2007 finished | 31.07.07 | Ok |
| M 3.4 | Sampling programme 2008 finished | 31.07.08 | Ok |
| M 3.5 | Investigation on food chains planned in detail | 31.03.08 | Ok |
| M 3.6 | Sampling of data for food chain analyses finished | 31.08.08 | Ok |

** Deviations are to be further discussed in D*

Deliverables list (from application)

| **Workpackage 4** | | | | | | |
|---|---|---|---|---|---|---|
| **Delive-rable No** | **Deliverable title** | **Lead sci-en-tist** | **Delivery date** | **Allocated scientific person moths** | **Type of de-liver-able** | **Fulfilled (ok) or devia-tions (d)*** |
| 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 pro-duction in hedges on organic and conven-tional farms. | BST | submitted 31.12.2010 | 1,1 | P | |

** Deviations are to be further discussed in D*

Milestones list (from application)

| **Workpackage 4** | | | |
|---|---|---|---|
| **Mileston No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or devia-tions (d)*** |
| M 4.1 | Sampling programme for flowering period and seed production planned in de-tail | 30.04.07 | Ok |
| M 4.2 | Sampling programme 2007 finished | 30.09.07 | Ok |
| M 4.3 | Sampling programme 2008 finished | 30.09.08 | |
| M 4.4 | Results made available for the synthesis | 31.01.09 | |

** Deviations are to be further discussed in D*

| Workpackage 5 | | | | | | |
|---|---|---|---|---|---|---|
| **Delive-rable No** | **Deliverable title** | **Lead scien-tist** | **Delivery date** | **Allo-cated scien-tific person moths** | **Type of de-liver-able** | **Fulfilled (ok) or devia-tions (d)*** |
| D5.1 | Publication 1: Dispersal patterns of small mammals in organic and conventional farms (submitted, April 2008) | TSJ | 30.04.2008 | 8 | S | d |
| D5.2 | M.Sc. Thesis (June 2008) | TSJ | 31.07.2008 | 1 | O | d |
| D5.3 | Publication 2: Small mammal diversity and density in organic and conventional farms (submitted March 2008) | TSJ | 31.03.2009 | 8 | S | d |
| D5.4 | Congress poster 2: As above (August 2009) | TSJ | 31.08.2009 | 0.5 | O | |
| D5.5 | Congress poster 1: As above (August 2010) | TSJ | 31.08.2010 | 1 | O | |

| Workpackage 5 | | | |
|---|---|---|---|
| **Mileston No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or devia-tions (d)*** |
| M5.1 | Establishment of grids and traplines, genetic sampling | 31.05.07 | d |
| M5.2 | Dispersal studies and telemetry of small mammals | 31.09.07 | d |
| M5.3 | Genetic sampling publication 1 | 31.05.08 | d |
| M5.4 | Nature quality sampling | 31.09.08 | d |
| M5.5 | Data analysis publication 2 | 31.12.09 | |
| M5.6 | Models, synthesis and final report. | 30.06.10 | |

** Deviations are to be further discussed in D*

Deliverables list (from application)
** Deviations are to be further discussed in D*

| **Workpackage 6** | | | | | | |
|---|---|---|---|---|---|---|
| **Delive-rable No** | **Deliverable title** | **Lead scien-tist** | **Delivery date** | **Allo-cated scien-tific person moths** | **Type of de-liver-able** | **Fulfilled (ok) or devia-tions (d)*** |
| D6.1 | Scientific publication: Genetic dispersal rate and direction of the field vole *Microtus agrestis.* Conventional versus organic farm-ing (Ph.D). | LWA | submitted 31.07.2010 | 4 | S | d |
| D6.2 | Scientific publication: Genetic dispersal rate and direction of the grey partridge, *Perdix perdix.* Conventional versus organic farm-ing (Ph.D). | LWA | submitted 31.07.2010 | 4 | S | d |
| D6.3 | 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 |
| D6.4 | Scientific publication: Genetic dispersal rate and direction of the ground beetle, *Bembid-ion lamrpus.* Conventional versus organic farming. | LWA | submitted 31.10.2010 | 8.9 | S | d |
| D6.5 | Ph.D. thesis delivered. | LWA | 31.07.2010 | 2 | O | d |
| D6.6 | Report: The role of organic farms as genetic sources for species in the arable land. | LWA | 31.12.2010 | 3 | R | d |

** Deviations are to be further discussed in D*

| **Workpackage 6** | | | |
|---|---|---|---|
| **Mileston No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or devia-tions (d)*** |
| M6.1 | Testing of primers for the ground beetle, field vole and grey partridge and start of genetic analyses in the laboratory start. | 01.09.07 | d |
| M6.2 | Ph.D. start | 01.08.07 | d |
| M6.3 | Genetic analyses of the three species in the laboratory continued from the first sampling period and second sampling period (Ph.D. and technician) finished. | 31.12.08 | d |
| M6.4 | Genetic analyses of the grey partridge (depending on sampling success) fin-ished. | 31.03.09 | |
| M6.5 | Data analyses of the genetic data completed and writing of papers in process. Feeding data to WP7. | 31.12.09 | d |
| M6.6 | Writing papers and Ph.D. completed (31.07.10). | 31.07.10 | d |
| M6.7 | Development of migration model for the ground beetle completed and writing of scientific publications (submitted) and report completed. | 31.12.10 | d |

** Deviations are to be further discussed in D*

| **Workpackage 7** | | | | | |
|---|---|---|---|---|---|

| Deliverable No | Deliverable title | Lead scientist | Delivery date | Allocated scientific person moths | Type of deliverable | Fulfilled (ok) or deviations (d)* |
|---|---|---|---|---|---|---|
| D7.1 | 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 |
| 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. | CJT | 30.09.2010 | 2 | S | |
| D7.3 | Scientific publication on the development and application of the landscape index for wildlife. | CJT | 31.12.2010 | 2 | S | |
| D7.4 | 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 | |

** Deviations are to be further discussed in D*

| **Workpackage 7** | | | |
|---|---|---|---|
| **Milestone No** | **Milestone title** | **Delivery date** | **Fulfilled (ok) or deviations (d)*** |
| M7.1 | Scenario inputs data (configurations) completed | 30.06.08 | d |
| M7.2 | ALMaSS Scenarios completed | 31.12.09 | |
| M7.3 | Development and application of landscape index complete | 30.06.10 | |
| M7.4 | Report (D7.1) (Project conclusion ) | 31.12.10 | |
| | | | |

## D. Description of deviations and subsequent adjustments of plans

**WP2**: Re M2.2: A preliminary organic farm typology is defined, and is now ready for implementation in GIS. However, for the benefit of the project we have not finally fixed the typology, which during the coming 2 years will be further developed together with the other ongoing activities in the work-packages of the project (especially WP7)

**WP4:** The 2007-data on hedgerow diversity gave a very good relation between management practice and diversity, therefore the 2008 field work has been dedicated to a thorough investigation of the causes for the observed differences including differences in soil nitrogen content and seed bank. Due to that the field work will be finished early October instead of 30.09.08.

**WP5:**

M5.1 In order to collect samples for the genetic analysis the first trapping of field vole was performed in spring 2007 in the study areas at Kalø and Bjerringbro, Denmark representing both organic and conventional farms. The study areas contained hedges, meadows, small biotopes, ditches etc. Unfortunately, the population size of the field voles was very low which made it impossible to collect sufficient number of individual for the genetic analysis. Due to the low density of the species the collection-period was extended and trapping were performed in autumn 2007 and winter 2007/2008 and will be repeated in this autumn 2008 and winter 2008/2009.

M5.2 “Dispersal studies and telemetry” will be postponed and will be fulfilled in autumn 2008 and winter 2008/2009 instead.

M5.3 “Genetic sampling publication 1” will be postponed due to the low number of field voles in spring and autumn 2007.

M5.4 “Nature quality sampling” spring and autumn 2008. For the biodiversity index based on the small mammalian fauna the field work ended in September 2008. The biodiversity study consisted of four parts involving 1) hedges, 2) small biotopes, 3) fields with crop and 4) grass areas.

**WP6**: As a result of the fusion in 2007 between University of Aarhus and NERI in 2007, the different schools of sciences were brought together, but we succeeded to apply for 1/3 of the Ph.D. at ISOBIS just before. However, the decision regarding how to continue the new constellation of science schools and how to distribute the grants amongst the different Ph.D. projects during the changeover were delayed, and a positive confirmation of the grant was received beginning of November, 2007, while the deadline for application through the University was 15.th of November. This resulted in very few not qualified applicants hence the position had to be advertised again in May 2008. This time a highly qualified applicant was appointed and the student started 01/09-2008. The lab-work has just begun and is progressing fast. The genetic analysis of the beetle from the first sampling period will be finished mid 2009, while the genetic analysis from the second sampling period will be finished by mid-2010 and the statistical analysis will be completed at the end of 2010 due to the delay. The laboratory analysis of the field vole and grey partridge from the first sampling period will (as long as it is progressing as expected) be finished by the end of the year 2008. The genetic analysis of the second sampling round of the field vole will finished by the end of 2009, while the statistical analysis of the field vole is expected to be completed mid 2010. The Ph.D. will be delivered 31.08.11 after completion of the report to ICROFS, hence the final report will not include the results of the genetic analysis of the second sampling round of the beetle.

**WP7**
D7.1 delayed because of late PhD start.
D7.2 & D7.3 – delivery date is switched. Not expecting delays
M.7.1 requires M2.2 which is delayed

## E. Project publications and other products

### 1. Products from Organic Eprints archive

Dalgaard, T.; Hutchings, N. and Kjeldsen, C. (2008) Samspillet mellem landbrugets struktur-udvikling og naturbeskyttelse i forskellige EU-lande. Paper presented at Pantekongres 2008., Herning Kongrescenter, 8-9 Januar 2008; Published in *Sammendrag af indlæg: Plantekongres 2008.* 1, page pp. 288-289. Dansk Landbrugsrådgivning & Det Jordbrugsvidenskabelige Fakultet..*

Dalgaard, T.; Kjeldsen, C. and Kristensen, I.T. (2008) Hvordan kan økologisk jordbrug være med til at styrke vækst og udvikling i landdistrikterne? . Paper presented at Plantekongres 2008. Dansk Landbrugsrådgivning & Det Jordbrugsvidenskabelige Fakultet., Herning, 8-9 Januar 2008; Published in *Sammendrag af indlæg: Plantekongres 2008.* 1(ISBN 978-87-91949-10-4), page pp. 164-165. Dansk Landbrugsrådgivning & Det Jordbrugsvidenskabelige Fakultet..*

Pugesgaard, S.; Dalgaard, T.; Jørgensen, U.; Olesen, J.E.; Møller, H. and Jensen, E.S. (2008) Can on-farm bioenergy production make organic farming more sustainable? - A model for energy balance, nitrogen losses, and green house gas emissions in a 1000 ha energy catchment with organic dairy farming and integrated bioenergy production. Poster presented at FAO Workshop on Organic Agriculture and Climate Change. June 18, 2008. The IFOAM World Organic Congress, Modena, Italy., http://www.fao.org/organicag/pdf/dalgaard_posters.pdf, June 18-20 2008.*

**Other products (oral presentations, public meetings, field days, etc.)**
There is no scientific publication from the project due to the early days. However, information on the project is given at the website http://www.refugia.elr.dk, http://www.refugia.elr.dk/uk/, http://www.foejo.dk/, http://www.darcof.dk/, and in FØJOeNyt , "Nyhedsbrev fra FØJO" August 2007, DMUNyt no. 14 6. Sept. 2007, AUgustus no.2 June 2007: Økologi v.s. markens dyr og planter. pp 28-29
A folder describing the project was presented at the 2nd ISOFAR Scientific Conference in Modena, Italy from 16-20 of June 2008.
The master thesis by Kimmie Knakkegård Christensen is published as: Christensen, KKK. (2008) herbicidet Starane 180S' effekt på pollen produktionen hos mælkebøtte og rødkløver - påvirkninger af fødeudbudet i markhegn på konventionelle og økologiske brug. Specialerapport Københavns Universitet, Institut for Økologi, marts 2008. Pp 73.
A poster was presented at the SETAC Europe 18th Annual meeting in Warsaw, Polen titled: "Effects of herbicide drift on hedgerow biodiversity" by Beate Strandberg and KK Christensen

## F. Scientific education

The master student, Kimmie Knakkegaard Christensen, connected to WP4 finished her master thesis the 4th of April 2008. The objective of the thesis was to analyse the data from the hedges and to look at the effect of the herbicide"Starane" on the flowering time and pollen production of dandelion and red clover.

The master student connected in 2007 to the telemetry part of the project in WP5 did not continue

A Ph.D. student is included in WP6. The purpose of the project "Landscape population genetics and the role of organic farming" is to analyse the landscape genetics of the ground beetle and the field vole from nearby conventional and organic farms in order to identify the micro evolutionary processes of gene flow and drift within the two kind of farming methods to address the role of organic farms as gene resource

## G. National and international cooperation

There is continuous international cooperation with the partners in the EU-network "Landscape Tomorrow" (http://www.landscape –tomorrow.org/) and with the EU-project MEA-scope (htpp://www.mea-scope.org/).
WP4 participate in a consortium working on an EU-application, FP7, in the Area 6.2.1.4 Biodiversity ENV. 2009.2.4.1 Assess the pan-European status of pollinators.

## H. Critical reflection on the project

**WP2**: The farm data set-up for the REFUGIA project has served as an important input to ICROFS "Videnssyntese om vækst og udvikling I økologisk jordbrug", but it is important that the conclusions and farm typing set-up for this task is further developed and detailed for the use in REFUGIA. Therefore, it is important that the farm typologisation is made flexible, so that it can be iteratively revised during the project and I close coordination with the other work packages.

**WP 3**: In 2008 field sampling only took place in weed-rich spots, due to last year's experience that organic cereal fields are very rich in weeds. This led to the conclusion that no further sampling of the general weed level was needed and that all the man-power intended for field sampling was needed to sample the weed-rich areas in order to study the relation between weed and insect biomass and diversity.

**WP4**: A significant relationship between management practice and hedgerow vegetation and flowering was established based on the thirty hedgerows sampled in 2007. Therefore, the sampling in 2008 was concentrated on the characterisation of other differences among these hedgerows than management type. We have taken soil samples to measure soil nitrogen levels and seed bank. Furthermore, mapping of the hedgerow uplands (area in rotation, area with permanent pastures, area with forest and other natural habitats) has been carried out.

**WP5:**
Sampling for genetic analysis
The population size of the field voles was very low in 2007 and it was not possible to collect sufficient number of individual for the genetic analysis. The sampling period was postponed to autumn 2008 and winter 2008/2009.

Telemetry studies of the field vole
In summer 2007 a master student started, but unfortunately he stopped after a few trapping sessions. We have hoped for another master student to do the telemetry study in the summer and autumn 2008, but it has not been possible. Instead we will do the telemetry study our selves in the autumn 2008 and winter 2008/2009.

For **WP6** the project included a Ph.D. study where the genetic analysis depended on samples from the field vole and a ground beetle. Due to the low numbers of field voles and the altered conditions for Ph.D. funding it was unwise to start the analysis in the laboratory in 2007. The last 2/3 of the Ph.D. was granted and the student started 01/09-2008. This has the consequence that the completion of the Ph.D. will be at the end of 2011, which will delay D6.3, D6.4 and D6.5
Due to problems catching beetles in pit-fall traps the beetles will be caught manually in 2009.

The grey partridge faeces will be sampled during the autumn 2008 and winter 2009 again, but the success depends on the winter weather. It is not possible to predict the number of individuals sampled but this will be revealed through very thorough laboratory analyses. Hence, it might be difficult to differentiate whether differences between the areas actually can be ascribed to the farming practice.
The genome-scan introduced to detect the genetic markers in the beetle is novel and made possible during the last couple of years due to the fast development of new laboratory techniques and machinery. This approach will furthermore enable the possibility of detecting genes (i.e. genes involved in stress or resistance) that will be under selection and make it possible to detect recent patterns of adaptation.

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## 8. Budget

### A. Account for any change in budgets

**WP2**: DJF-JPM has moved forward a minor part of the budget for 2009 and 2010. This will help to support the revisions needed of the farm typology defined (see point D M2.2), and help to focus the publication activities planned for the coming years.

**WP5:** Scientific personnel: Kr. 6.426 has been moved from 2007 to 2009 due to low number of animals. Technical personnel: Kr. 42.320 has been moved from 2008 to 2009 due to the low number of animals. The technical personnel are needed for dissection etc of specimens.
Other operational costs:
Kr. 48.295 has been moved from 2007 to 2009 as telemetry studies have been postponed.

**WP6:** Due to the earlier described fusion between NERI and AAU and of the different science schools, the specification of salary and operational costs in the amount (510,000Dkr) reserved for 1/3 Ph.D. has been changed, therefore we apply to transfer, Dkr 25,000 to AAU as a study fee and Dkr 135,000 from salary to operational costs in order to run a genome-scan of the beetle and pay bench-fee at the laboratory where the genome-scan should be performed in 2008.

Deviations regarding milestones and deliverables given above accounts for the changes in the

budgets from the different institutions and departments participating in the project. The changes are specified in the different budgets under “Comments” for each department.

**B. Budget for the whole project (1.000 DKK)**

Total consumption of funds from DARCOF and expected consumption this year and coming years

| Year: | Original budget | Expected consumption 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Man-months | | | | | | |
| Scientific personnel | 80 | 11.8 | 19.8 | 26.05 | 22.35 | 80 |
| Technical personnel | 49.28 | 18 | 23.6 | 8.1 | 0.48 | 50.18* |

| Year: | Original budget | Expected consumption 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Salaries | | | | | | |
| Scientific personnel | 3,659,509 | 516,359 | 843,909 | 1,142,496 | 997,020 | 3,499,784** |
| Technical personnel | 1,527,144 | 488,965 | 748,124 | 255,272 | 15,000 | 1,507,361** |
| Other operational costs | 620,087 | 136,540 | 311,000 | 297,144 | 59,000 | 803,684** |
| Equipment | 16,000 | | 16,000 | | | 16,000 |
| Others (please specify) | 5,000 | | | | 5,000 | 5,000 |
| Direct costs | 5,822,740 | 1,141,864 | 1,973,033 | 1,640,912 | 1,076,020 | 5,831,829*** |
| Indirect costs (20% of direct costs) | 1,164,546 | 228,973 | 395,011 | 311,410 | 230,970 | 1,166,364*** |
| Total | 6,987,286 | 1,370,837 | 2,368,045 | 1,952,322 | 1,306,990 | 6,998,194*** |

**Comments: *** The 0.9 tap month used by TERI
** Deviations caused by VIBI due to changes in Ph.D.conditions and agreements
***Due to deviations explained by VIBI, TERI and Natural History Museum.

## 9. Signatures and stamps

| Name | Institute | Date | Signature |
|---|---|---|---|
| Head of project<br>Liselotte Wesley Andersen | Dept. of Wildlife Ecology and Biodiversity, NERI, University of Aarhus, Denmark | 30.09.2008 | |

# Appendix I. Detailed budget

**B. Budget for each participating department (1.000 DKK)**

Name of Institute and department: Agroecology & Environment, Faculty Agricultural Science, AU (DJF-JPM)
F-03491 REFUGIA

| Year: 2008 | Original budget | Consump-tion 2007 | Expected consump-tion 2008 | 2009 | 2010 | 2011 | Total |
|---|---|---|---|---|---|---|---|
| Man-months | | | | | | | |
| Scientific personnel | 8.25 | 1.6 | 1.5 | 3.65 | 1.5 | | 8.25 |
| Technical personnel | 2.98 | 0 | 1 | 1.5 | 0.48 | | 2.98 |

| Year: 2008 | Original budget | Consump-tion 2007 | Expected consump-tion 2008 | 2009 | 2010 | | Total |
|---|---|---|---|---|---|---|---|
| Salaries | | | | | | | |
| Scientific personnel | 448 | 87 | 80 | 199 | 82 | | 448 |
| Technical personnel | 93 | 3 | 30 | 45 | 15 | | 93 |
| Other operational costs | 93 | 2 | 43 | 23 | 25 | | 93 |
| Equipment | 16 | 0 | 16 | 0 | 0 | | 16 |
| Others (please specify) | | | | | | | |
| Direct costs | 650 | 92 | 223 | 213 | 122 | | 650 |
| Indirect costs (20% of direct costs) | 130 | 19 | 44 | 43 | 24 | | 130 |
| Total | 780 | 111 | 267 | 256 | 146 | | 780 |
| | | | | | | | |

Name of Institute and department:
National Environmental Research Institute (NERI), University of Aarhus, Department of Wildlife Ecology and Biodiversity. Grenåvej 12, 8410 Rønde, Denmark

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | Expected consumption 2009 | Expected consumption 2010 | Total |
|---|---|---|---|---|---|---|
| Man-months | | | | | | |
| Scientific personnel | 35.7 | 1 | 9 | 12.5 | 13.2 | 35.7 |
| Technical personnel | 0.8 | 0 | 0.8 | 0 | 0 | 0.8 |

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | Expected consumption 2009 | Expected consumption 2010 | Total | Difference |
|---|---|---|---|---|---|---|---|
| Salaries | | | | | | | |
| Scientific personnel | 1,610,668 | 44,455 | 360,000 | 500,000 | 546,213 | 1,450,668 | -160,000 |
| Technical personnel | 26,974 | | 26,974 | 0 | 0 | 26,974 | 0 |
| Other operational costs | 263,287 | 3,438 | 206,000 | 193,849 | 20,000 | 423,287 | 160,000 |
| Equipment | | | | | | | , |
| Others (please specify) | | | | | | | |
| Direct costs | 1,900,929 | 47,893 | 592,974 | 693,849 | 566,213 | 1,900,929 | 0 |
| Indirect costs (20% of direct costs) | 380,186 | 9,578 | 119,600 | 121,598 | 129,409 | 380,185 | 0 |
| Total | 2,281,115 | 57,471 | 712,574 | 815,447 | 695,622 | 2,281,114 | |

**Comments:**
Of the operational costs Dkr 173,000 is transferred to 2009.
8 scientific months are transferred to 2009 due to the delay in the start of the Ph.D.
The 160,000 is transferred from salary to operational costs to be used for a genome-scan of the beetle and bench fee.

Name of Institute and department: National Environmental Research Institute (NERI), University of Aarhus, Department of Terrestrial Ecology

| Year: | Original budget total | Revised budget total | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total | Difference |
|---|---|---|---|---|---|---|---|---|
| Man-months | | | | | | | | |
| Scientific personnel | 16.55 | 16.55 | 3.4 | 3.5 | 4 | 5.65 | 16.55 | 0 |
| Technical personnel | 42 | 42 | 16 | 21.8 | 5.1 | 0.0 | 42.9 | -0.9 |

| Year: | Original budget total | Revised budget total | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total | Difference |
|---|---|---|---|---|---|---|---|---|
| Salaries | | | | | | | | |
| Scientific personnel | 778,865 | 778,865 | 153,349 | 161,161 | 188,354 | 276,001 | 778,865 | - |
| Technical personnel | 1,306,947 | 1,287,439 | 429,337 | 691,150 | 166,952 | - | 1,287,439 | (0) |
| Other operational costs | 74,000 | 93,508 | 51,397 | 20,000 | 17,000 | 14,000 | 102,397 | (8,889) |
| Equipment | | | | | | | | |
| Others (please specify) | | | | | | | | |
| Direct costs | 2,159,812 | 2,159,812 | 634,083 | 872,311 | 372,306 | 290,001 | 2,168,701 | (8,889) |
| Indirect costs (20 % of direct costs) | 431,962 | 431,962 | 126,817 | 174,462 | 74,461 | 58,000 | 433,741 | (1,778) |
| Total | 2,591,774 | 2,591,774 | 760,900 | 1,046,774 | 446,767 | 348,001 | 2,602,442 | (10,668) |

**Comments:**

6 lab-months moved from 2007-2008
350 technician-hours moved from 2008 to 2009

The expense for technical-personnel help in 2008 was lower compared to the original budget due to use of student help. The amount 19,508 kr. is transferred to operational costs.

The original budgeted operational costs is lower than the actual operational costs used due to expenses used for transport in connection with the field work that has not been included in the original budget. The difference is covered by NERI.

Name of Institute and department:
Natural History Museum, Aarhus, Wilhelm Meyers Allé 210,
8000 Aarhus C

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Man-months | 23 | | | | | |
| Scientific personnel | 19.5 | 5.8 | 5.8 | 5.9 | 2.0 | 19.5 |
| Technical personnel | 3.5 | 2.0 | | 1.5 | | 3.5 |

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Salaries | | | | | | |
| Scientific personnel | 822,251 | 231,555 | 242,748 | 255,142 | 92,806 | 822,251 |
| Technical personnel | 99,948 | 56,628 | | 43,320 | | 99,948 |
| Other operational costs | 185,000 | 79,705 | 42,000 | 63,295 | 0 | 185,000 |
| Equipment | | | | | | 0 |
| Others (please specify) | 5,000 | | | | 5,000 | 5,000 |
| Direct costs | 1,112,199 | 367,888 | 284,748 | 361,757 | 97,806 | 1,112,199 |
| Indirect costs (20% of direct costs) | 222,439 | 73,578 | 56,949 | 72,351 | 19,561 | 222,439 |
| Total | 1,334,638 | 441,466 | 341,697 | 434,108 | 117,367 | 1,334,638 |

**Comments:**

## C. Budget for co-financing from each participating institute (1.000 DKK)

Name of Institute and department:
Agroecology & Environment, Faculty Agricultural Science, AU (DJF-JPM)
F-03491 REFUGIA

| Year: 2008 | Original budget | Con-sumption 2007 | Expected consump-tion 2008 | 2009 | 2010 | 2011 | Total |
|---|---|---|---|---|---|---|---|
| Man-months<br><br>Scientific personnel<br><br>Technical personnel | | | | | | | |

| Year: 2008 | Original budget | Consump-tion 2007 | Expected consump-tion 2008 | 2009 | 2010 | | Total |
|---|---|---|---|---|---|---|---|
| Salaries<br><br>Scientific personnel<br><br>Technical personnel | | | | | | | |
| Other operational costs | | | | | | | |
| Equipment | | | | | | | |
| Others (please specify) | | | | | | | |
| Direct costs | | | | | | | |
| Indirect costs<br>(20% of direct costs) | 196 | 38 | 56 | 65 | 37 | | 196 |
| Total | 196 | 38 | 56 | 65 | 37 | | 196 |
| | | | | | | | |

Name of Institute and department:
National Environmental Research Institute (NERI), University of Aarhus, Department of Wildlife Ecology and Biodiversity. Grenåvej 12, 8410 Rønde, Denmark

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Man-months<br><br>Scientific personnel<br><br>Technical personnel | | | | | | |

| Year: | Original budget | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Salaries<br><br>Scientific personnel<br><br>Technical personnel | | | | | | |
| Other operational costs | | | | | | |
| Equipment | | | | | | |
| Others (please specify) | | | | | | |
| Direct costs | 2,205,078 | 55,556 | 687, | 804 | 656,807 | |
| Indirect costs (20% of direct costs) | 380,186 | 9,578 | 118, | 138 | 113,243 | |
| Total | 1,824,892 | 45,978 | 569, | 666 | 543,564 | 1,824,89 |

**Comments:** Co-financing consists of the difference between the allowed indirect costs (20 %) and the actual indirect costs (116 %).

Name of Institute and department:
National Environmental Research Institute (NERI), University of Aarhus, Department of Terrestrial Ecology

| Year: | Original budget total | Consumption 2007 | Expected consumption 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|
| Man-months<br>Scientific personnel<br>Technical personnel | | | | | | |

| Year: | | | | | | |
|---|---|---|---|---|---|---|
| Salaries<br>Scientific personnel<br>Technical personnel | | | | | | |
| Other operational costs | | | | | | |
| Equipment | | | | | | |
| Others (please specify) | | | | | | |
| Direct costs | | | | | | |
| Indirect costs<br>(20 % of direct costs) | | | | | | |
| Total | 2,073,420 | 608,720 | 837,419 | 357,414 | 278,401 | 2,081,953 |

**Comments:**
Co-financing consists of the difference between the allowed indirect costs (20 %) and the actual indirect costs (116 %).