Loire Valley contribution

2nd technical seminar
Krems (Au),
8th-11th June 2010

The preservation of wine-growing areas in terms of sustainable agriculture, management of natural habitats and biodiversity conservation.

An example: biodiversity in a wine-growing region

Expert :

Guillaume PAIN, lecturer in landscape ecology, Groupe ESA, Unité Paysage *(Landscape research unit)* AGROCAMPUS OUEST / ESA, Angers.
In collaboration with Joséphine PITHON (lecturer, Groupe ESA, Unité Paysage AGROCAMPUS OUEST / ESA, Angers, Maarten van Helden (lecturer, ENITA de Bordeaux) et Marie-Anne Simonneau (project coordinator, Syndicat des producteurs de Saumur Champigny – *Wine-growers' union*)

Summary

Currently, viticulture has the reputation of being an intensive crop that consumes large quantities of pesticides and is therefore of little interest for biodiversity. However, since the 1990s, wine-growers' practices and objectives have evolved to become more environmentally conscious. As such, in the Loire Valley, the use of beneficial insects to help control vine pests, the increasing use of green cover between rows of vine or the emergence of Terra Vitis' environmental policy are examples of this change.

These environmental approaches, implemented at farm scale, are now well known and can be considered "classic" in 2010. In recent years, the question of how to bring ecology and agriculture closer, the development of approaches such as agroecology, but also the increasing interest in landscape scales for the management of natural resources and system sustainability have led to a new field of innovation: planning for sustainable agricultural regions.

Approaches at a regional or landscape scale, wider than the classical farm-scale framework, have in particular been developed in order to better integrate relationships between viticulture and biodiversity and the two-way benefits that could be strengthened to help control vine insect pests or to stop declines in common farmland biodiversity.

In the Loire Valley, a growing number of wine-growers are taking an interest in these approaches. The Saumur-Champigny controlled origin appellation, in partnership with research teams and other agricultural organisations, launched a major project on this topic more than five years ago. This habitat creation project aims to encourage biodiversity throughout the appellation zone and is of particular interest as it was initiated by the wine-growers themselves and deals with all aspects of sustainability (economic, environmental and social interests). This example may help to define those actions that could contribute to preserving vineyards while farming sustainably and managing and conserving natural habitats and biodiversity.

Contents

1. Introduction

Following the specialisation and intensification of farming practices from the 1970s to 90s, viticulture is nowadays considered to be an intensive crop with a highly negative environmental impact. In 2005, scientists[1] calculated that vineyards occupied 3% of French farmland and received 20% of the country's pesticides (data from the year 2000). More recent reviews of the relationships between agriculture and biodiversity generally consider vineyards to be of low value for biodiversity.
However, since the 1990s, viticulture has evolved; a number of innovations or changes to farming practices have come about, particularly in the Loire Valley: a stop to the use of acaricides and their stead the use of beneficial organisms such as phytoseiid mites, or the wider use of green cover to limit vine vigour. A major study of Loire Valley "terroirs" (areas belonging to specific soil/climatic contexts) has been carried out in order to better adapt production objectives and farming methods to local soil and climatic conditions. All these advances have also led to the development of an environmental approach and a « Terra Vitis » label which places an emphasis on the whole-farm approach rather than on the final product. The label requirements include criteria relating to health, hygiene, waste management, landscape and biodiversity. In parallel, a number of other farms have converted to organic farming.
These environmental approaches, implemented at farm scale, are now well known and can be considered "classic" in 2010. In recent years, the question of how to bring ecology and agriculture closer, the development of approaches such as agroecology, but also the increasing interest in landscape scales for the management of natural resources and system sustainability have led to a new field of innovation: planning for sustainable agricultural regions.
Five years ago, in the Loire Valley, a controlled origin appellation, in partnership with research teams, launched a habitat creation project at the appellation scale, with the objective of encouraging biodiversity and controlling vine pests. Other wine-growing areas in the Loire Valley and in France have taken similar approaches but we shall limit our presentation to the Saumur-Champigny AOC project as it is doubtless the most advanced of its kind. Indeed we feel that it is important to start sharing the lessons learned, to help other vineyards that may be ready to move in the same direction.

2. Agricultural landscapes and biodiversity

2.1. Biodiversity is not just a collection of plant and animal species

Biodiversity is a relatively new term but already tens of definitions exist. Blondel (2005) distinguishes three approaches to biodiversity: as an abstract and exhaustive concept describing the "variety of life" – an often biologically-centred almost fundamentalist approach; as a social, economic, legal and political construction; or as an object of study for the life sciences.

The definition agreed upon in the 1992 Convention for Biological Diversity is the following: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Hence the biodiversity concept is inclusive and not limited to a number or a diversity of species. Generally, biologists define three levels of biodiversity:

- genetic diversity;
- taxonomic diversity (species and populations);

[1] http://www.international.inra.fr/research/some_examples/pesticides_agriculture_and_the_environment

- ecosystem diversity.

Each level may be studied in terms of its composition (which genes, which species, which habitats?), its structure (how are species organised?) or its functions (what are the interactions between species in a community?).

2.2. Why preserve biodiversity? From a concern for nature conservation to a realisation of the importance of biodiversity functions

A number of reasons have been suggested as to why we should preserve biodiversity. Lévêque (1997 in LeRoux *et al.* 2008) identifies economic reasons, linked to the production of agricultural commodities, the regulation of major physical and chemical cycles, soil fertility, to tourism…as well as ethical and cultural reasons, referring to our moral duty towards future generations or to the need to maintain the adaptive and evolutionary potential of living organisms. Biodiversity conservation is therefore one of the important themes to be considered when studying the sustainability of any system.

Several studies have quantified the benefits provided to humanity by biodiversity, most dating from the 1990s. An assessment of the services provided by ecosystems, at a global scale, was carried out by the scientific community, funded by the UN, and it forms a part of the 2005 Millennium Assessment (available on the internet) (Figure 1).

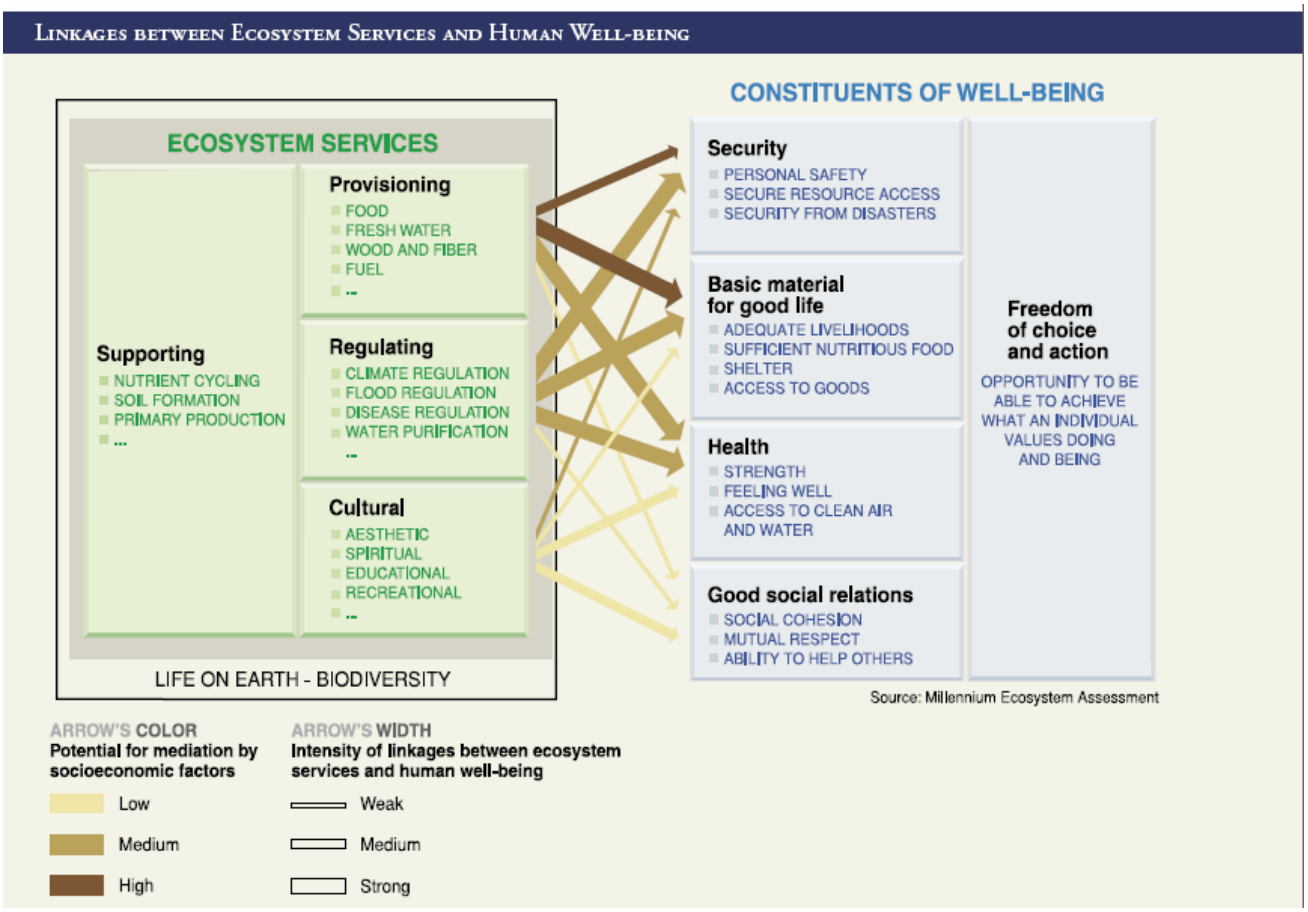

Figure 1 : the influence of biodiversity (the variety of life forms on the planet) on the constituents of well-being of human societies, through the maintenance of fertility, the provision of food and raw materials, the regulation of the climate and of flow of water and pollutants, cultural services (source : Millennium Ecosystem Assessment 2005)

Since the way in which biodiversity is viewed varies considerably, this has generated many studies describing different "types of biodiversity". Among others:

- domestic or agricultural diversity, referring to species and varieties farmed by man;
- biodiversity of conservation concern, referring to species and ecosystems, sometimes emblematic, which often benefit from protection;
- ordinary or common biodiversity, which is a part of everyday life and has become a focus of interest (particularly since the severe decreases in biodiversity associated with farmland have been revealed);
- functional biodiversity to which reference is often made in current discussions about the development of new forms of agriculture, and which can be viewed as that portion of biodiversity having an influence on ecological processes associated with one or more « services », such as the decomposition of organic matter, crop protection…

Following the rejection of various agricultural models that are very dependent on inputs (for example artificial fertilisers or phyto-pharmaceutical products), more and more attention is being given to this biodiversity, functional or otherwise, which could perhaps be harnessed in order to design new and more autonomous methods of production. Certain results from the field of ecology can help to identify the types of action or study that could contribute to maintaining biodiversity in farming areas.

Biodiversity has many potential benefits for agriculture. The state of knowledge in this field was recently published by the French body in charge of agricultural research (INRA) in the form of a group-led literature review « Agriculture et biodiversité – Valoriser les synergies » (Le Roux *et al.* 2008). In this work a number of services provided by biodiversity within agricultural ecosystems are identified, that may have positive effects on farming activities, on the quality of life and on the management of natural resources at regional scales (Figure 2).

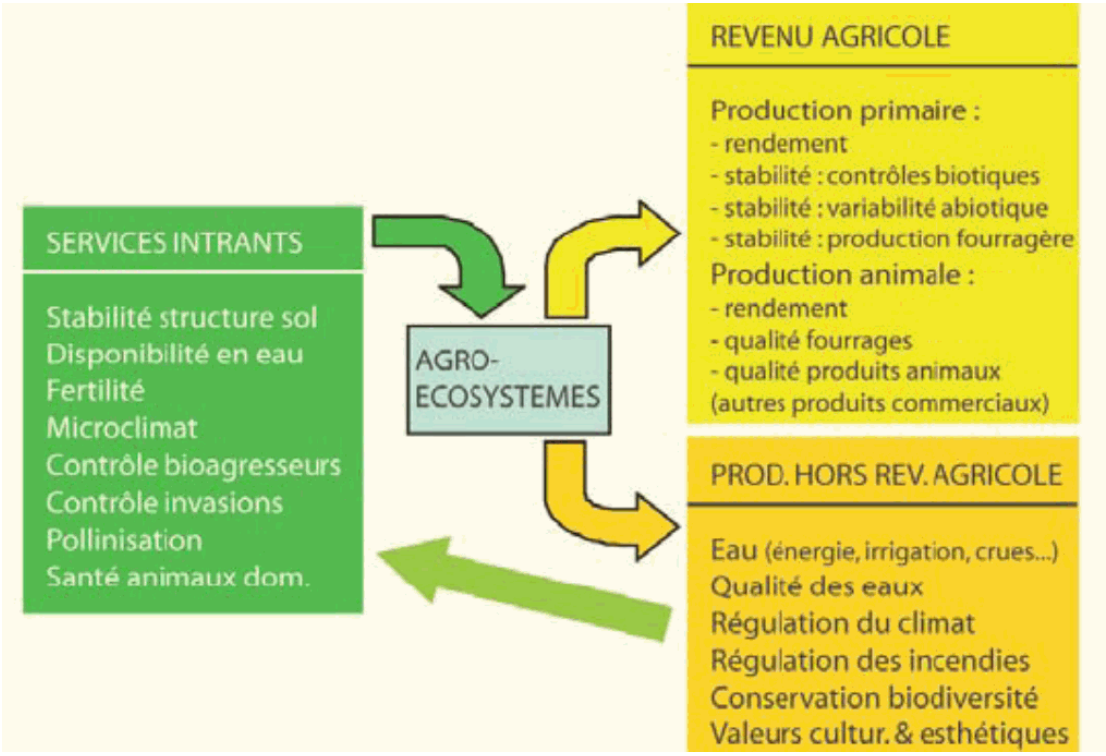

Figure 2 : the influence of biodiversity on agricultural income and on non-remunerated products via the input services it provides within agro-ecosystems (source : Le Roux *et al.* 2008)

Studies examining the ecological value of different types of agricultural landscape, have found viticulture to be an intensive monoculture generating homogeneous landscapes that support low levels of biodiversity. In this type of farmland, it would be beneficial to change production methods, in particular to limit the use of chemical inputs, but also to reduce landscape homogeneity (Figure 3).

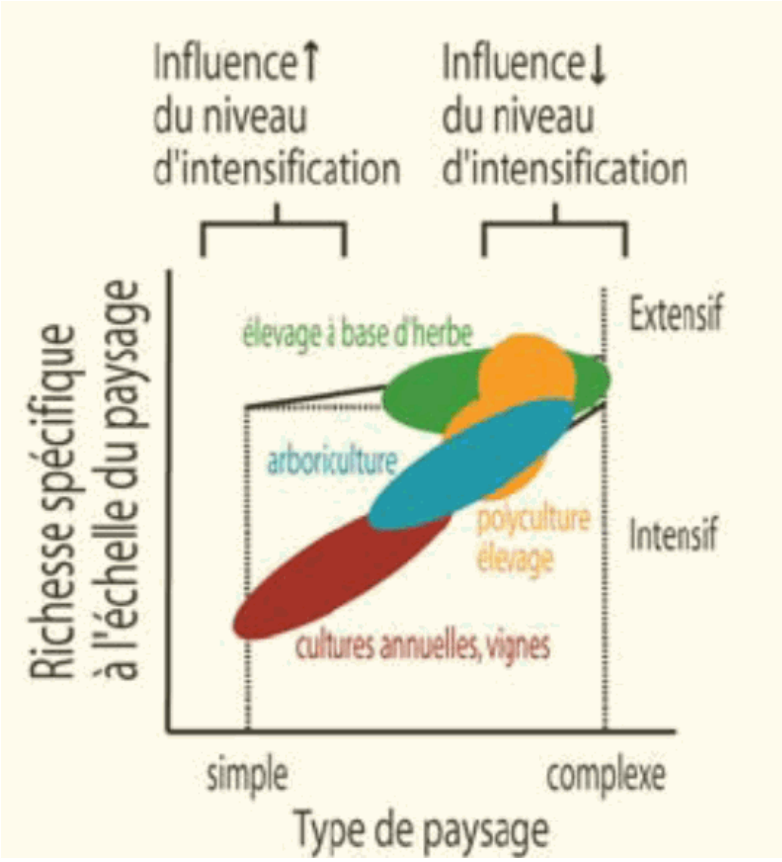

Figure 3 : the influence of agricultural intensification on number of species, depending on landscape structure. The more homogeneous the landscape, the more negative the effects of intensification of agricultural practices are likely to be. Vineyards are considered to be among the worst types of agriculture in biodiversity terms, generating homogeneous landscapes of intensive monoculture (source : Le Roux *et al.* 2008).

This second approach, at landscape scale, has as yet received little attention and would seem to be of particular interest in the context of work on the sustainability of agricultural landscapes, as in the case of the VITOUR project.

Among the services provided by biodiversity, the control of crop pests is one of the most widely studied. In the past few decades, approaches to crop protection have evolved from systems essentially based on the use of pesticides to more integrated approaches using alternative methods such as pest confusion using pheromones or releases of beneficial organisms (predatory or parasitic organisms of crop pests). More recently, another approach has developed: conservation biological control through habitat management. The objective here is to maintain populations of beneficial organisms within farmland. In order to achieve this, the fields themselves and their margins are managed in such a way as to provide sufficient habitat and resources to maintain large enough populations of beneficial organisms to have a real effect on pest population control. These managed or newly created semi-

natural habitats provide beneficial organisms with shelter to survive the winter months and food (prey items, nectar, pollen) to enable them to reproduce well before the arrival of pests in the crop fields.

As far as viticulture is concerned, few studies have been carried out on the ecology of vine pest insects and their predators or parasites, in relation to the structure and composition of characteristic wine-growing landscapes. The first attempts at conservation biological control in this context took place in Switzerland in the 1960s (Boller, 2006). The use of green cover between or under rows of vine encourages generalist predators such as spiders and beetles (Daane & Costello, 1998, Van Helden *et al.*, 2003), but also specialist parasitoids (English-Loeb *et al.*, 2003). The positive influence of hedges as areas of shelter (harbouring alternative host organisms) or migration corridors for natural enemies has also been shown (Corbett & Rosenheim, 1996, Nicholls *et al.*, 2001). Nevertheless, the real efficiency of such habitats on pest control is not yet completely proven since hedges may have different and sometimes contradictory effects on different pest and beneficial species. When hedges are planted with the objective of encouraging natural pest control mechanisms, it is therefore important to measure the real effects of the habitats created.

3. Experience from the Saumur Champigny controlled origin appellation vineyards

3.1. The Saumur Champigny controlled origin appellation (AOC) in the Loire Valley

This controlled origin appellation was created by interministerial decree on 31st December 1957 and covers an area producing red wine using mainly Cabernet franc grape varieties. Within the area, 120 viticulturists are declared. The vineyards cover approximately 1600 ha distributed over 9 communes: Saumur, Dampierre-sur-Loire (associée à Saumur), Parnay, Turquant, Chacé, Saint-Cyr-en-Bourg, Montsoreau, Champigny and Varrains (Figure 4). This area of 65km^2 is limited to the north by the Loire River and to the west by the Thouet River. The average production is 85000 hl/yr. Since the year 2000, half the AOC communes belong to the « Loire Valley, from Sully-sur-Loire to Chalonnes » UNESCO world heritage site, designated for its cultural landscapes.

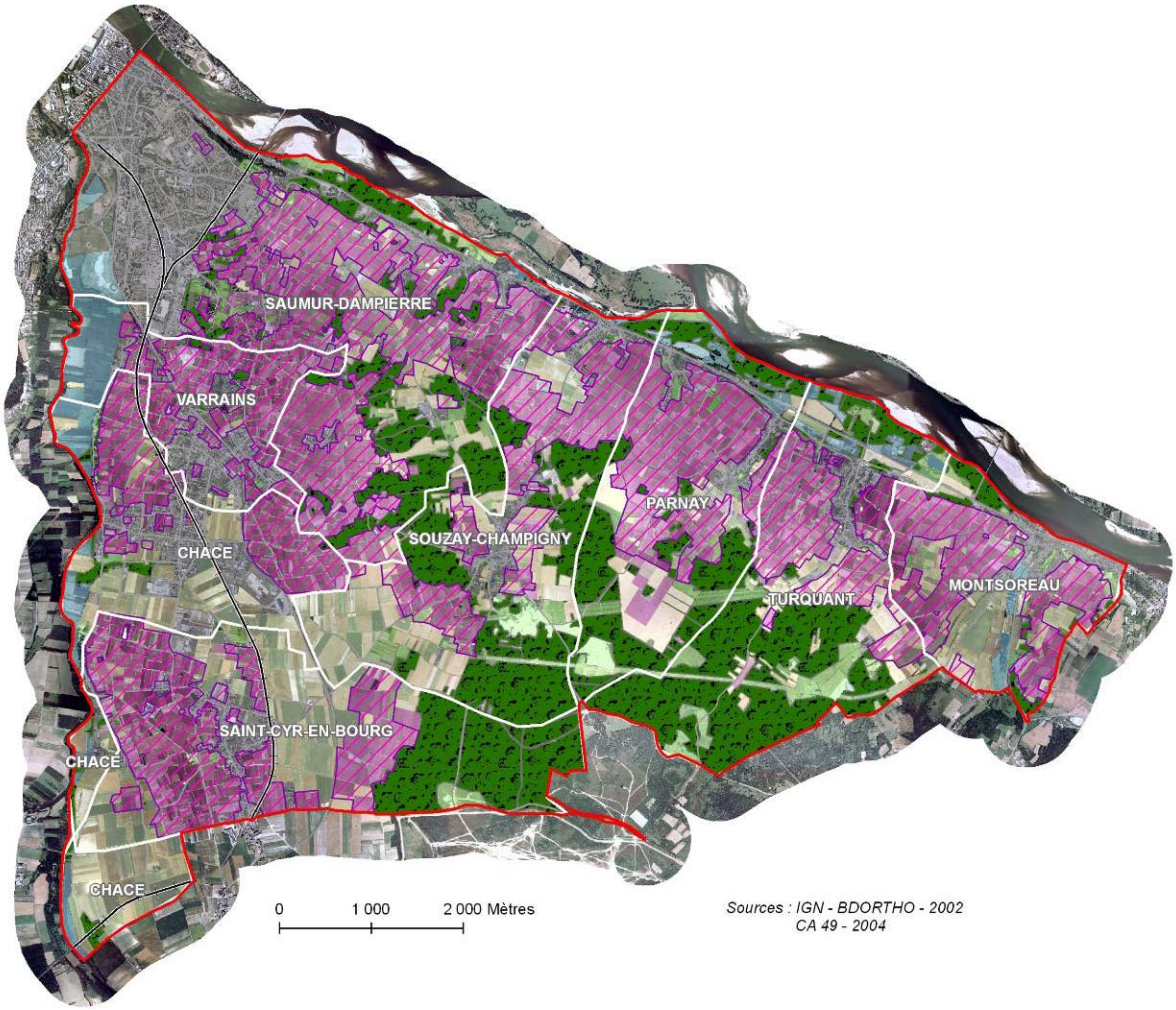

Figure 4 : the Saumur Champigny AOC area and its communal boundaries. In hatched purple, the land used to produce Saumur Champigny wine (source INAO); in green the north-west extremity of the Fontevraud forest. The site is delimited by the Thouet Valley to the west, and to the north by the Loire River; the town of Saumur is situated at the confluence of these two rivers in the north-west corner.

3.2. The « biodiversity and landscape » project

Since 2004, the Saumur-Champigny AOC has been involved in a « biodiversity and landscape » project coordinated by the wine producers' union. The objectives of this project, according to the union are the following:
« The viticulturists are cooperating to create a network of Ecological Compensation Areas (ECA), throughout the nine communes of the appellation area. The ECAs are uncultivated areas that receive no pesticides and fertilisers (hedges, grassy margins, stone walls…) […] to promote and to maintain biological diversity, to favour natural control mechanisms within the vine agro-ecosystem […] »[2]

The first two years of study and action were largely financed by a Leader+ project with four main parts: preliminary studies, communication, planting and research. In 2004, a mapping study undertaken by the Maine-et-Loire chamber of agriculture provided a distribution map showing the locations of vineyards with green cover, woodlands, stone walls and existing hedges. In 2005, a network of thirty traps was set up in order to study the effects of landscape structure on vine pest insects, overseen by Maarten Van Helden, lecturer in crop protection at ENITA, Bordeaux. In the same year, the first hedge-planting initiatives were launched with technical support from the chamber of agriculture. In order to cope with the volume of work associated with the project, the union recruited a coordinator in 2006 to manage the hedge-planting operations, to seek out new sources of funding and to act as a go-between for the different project partners: wine-growers, agricultural advisors, researchers and other local organisations (communes, agricultural college…). In 2007, the union completed its research and development project, produced in partnership with the chamber of agriculture, two research teams and a flower seed producer. This project was considered innovative and earned the financial support of the local authority (Région Pays de la Loire) from 2008 for a period of 5 years. It is this project which has helped to organise the union's "biodiversity and landscape" activities, through three main objectives:
Objective 1: development of biodiversity and creation of a functional landscape to control pests,
Objective 2: reduction of the number of chemical treatments used in the vineyard (pesticides and other inputs) and of their environmental impact,
Objective 3: creation of original features that can be used to develop the appellation's commercial image.

Four action points are defined and financed by the project:

- monitoring of vine pests and the publication of a warning newsletter, on the one hand to study pest population variations in space and time and on the other to assist the viticulturist in honing his insecticide use strategy;
- studying the wildlife (flora and fauna) occurring in the vineyards using rapid biodiversity assessment methods;
- defining a habitat creation plan for the AOC and setting up tools for monitoring changes in landscape structure
- experimenting to find types of green cover that encourage biodiversity

In addition to these research and innovation activities, there is communication on the theme of « biodiversity and landscape » and hedge-planting, subsidised by the local authority (Maine-et-Loire).

[2] Appellation website, visited in January 2007 - http://www.producteurs-de-saumur-champigny.fr/

Noteworthy:
- the project was initiated by the wine-growers themselves and they put in place methods to monitor its progress
- involvement of research partners, right from the start of the project;
- the need to recruit a coordinator to oversee the project and to act as a go-between for the different project partners;
- communication, allowing short-term returns on investment regardless of the real effects (unpredictable in view of the current state of knowledge) on biodiversity and pest control.

3.3. Landscape and vine pests

3.3.1. General approach

Most research in this field focuses on the biology of beneficial organisms: the identification of species that may be able to control pest species by predation or parasitism and the study of their ecological requirements in order to place plant species in field margins to encourage their presence. This approach, based on species' biology and predator-prey relationships allows a better understanding of the mechanisms underlying the control of certain pests but provides only partial knowledge of these phenomena. For example, certain studies have shown the presence of beneficial organisms in field edges, but without demonstrating their effects on pest control while other studies show that the individuals of some species are able to feed on pests but without there being a real and efficient pest control effect… For all these reasons, and in order to be in a position to provide short-term answers to wine-growers, Maarten van Helden has come up with an experimental design that instead of aiming to understand underlying mechanisms controlling pests, concentrates rather on the influence of the structure of landscapes surrounding vineyards, on pest populations. This approach has two major advantages:

- it enables us to directly test the existence of potential landscape structure effects on pest insects and hence the relevance of working on habitat creation
- it involves viticulturists in the study as they participate in trapping and provides them with information about pest dynamics that can help them to decide when to spray their crops.

3.3.2. Experimental protocol

Since 2005, around thirty fields from all over the appellation have been selected (Figure 5). These belong to wine-growers participating in the project and were selected to represent situations with or without green cover, and with or without woodland habitat in close proximity. At the centre of each field, two traps have been installed, allowing the four main vine pest insect species to be trapped:

- Vine leafhopper (*Empoasca vitis*), which pierces vine leaves causing them to dry out leading to yield losses;
- *Scaphoideus titanus*, which transports a serious vine disease (Flavescence dorée phytoplasma) requires contaminated vine plants to be destroyed and the need for large quantities of pesticides;
- And Grapevine moth (*Lobesia botrana*) and Grape berry moth (*Eupoecilia ambiguella*), whose larvae attack grapes and encourage rotting.

These traps are emptied twice a week from May to September and a newsletter summarising the main results from the network is sent to the wine-growers on a weekly basis.

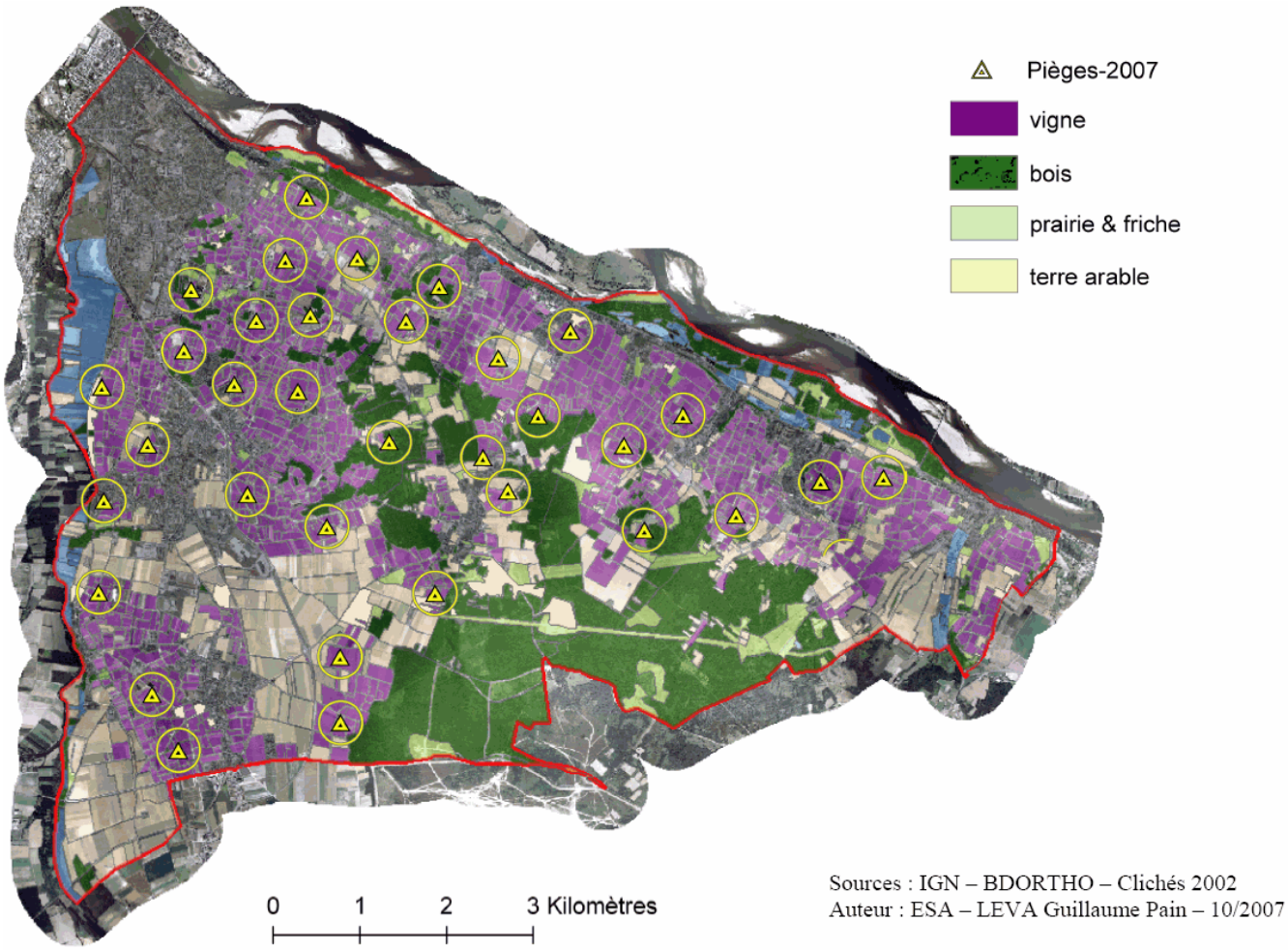

Figure 5 : Trap positions in the Saumur-Champigny AOC.

To test for a possible effect of landscape on the numbers of pests present in the vines, for each trap, neighbouring land cover is determined from analysis of aerial photographs and digitised in a geographical information system (GIS). This analysis covers the areas within a radius of 100 to 500m around each trap, and distinguishes areas of vine, woodland, built-up areas, arable crops and water features (Figure 6).

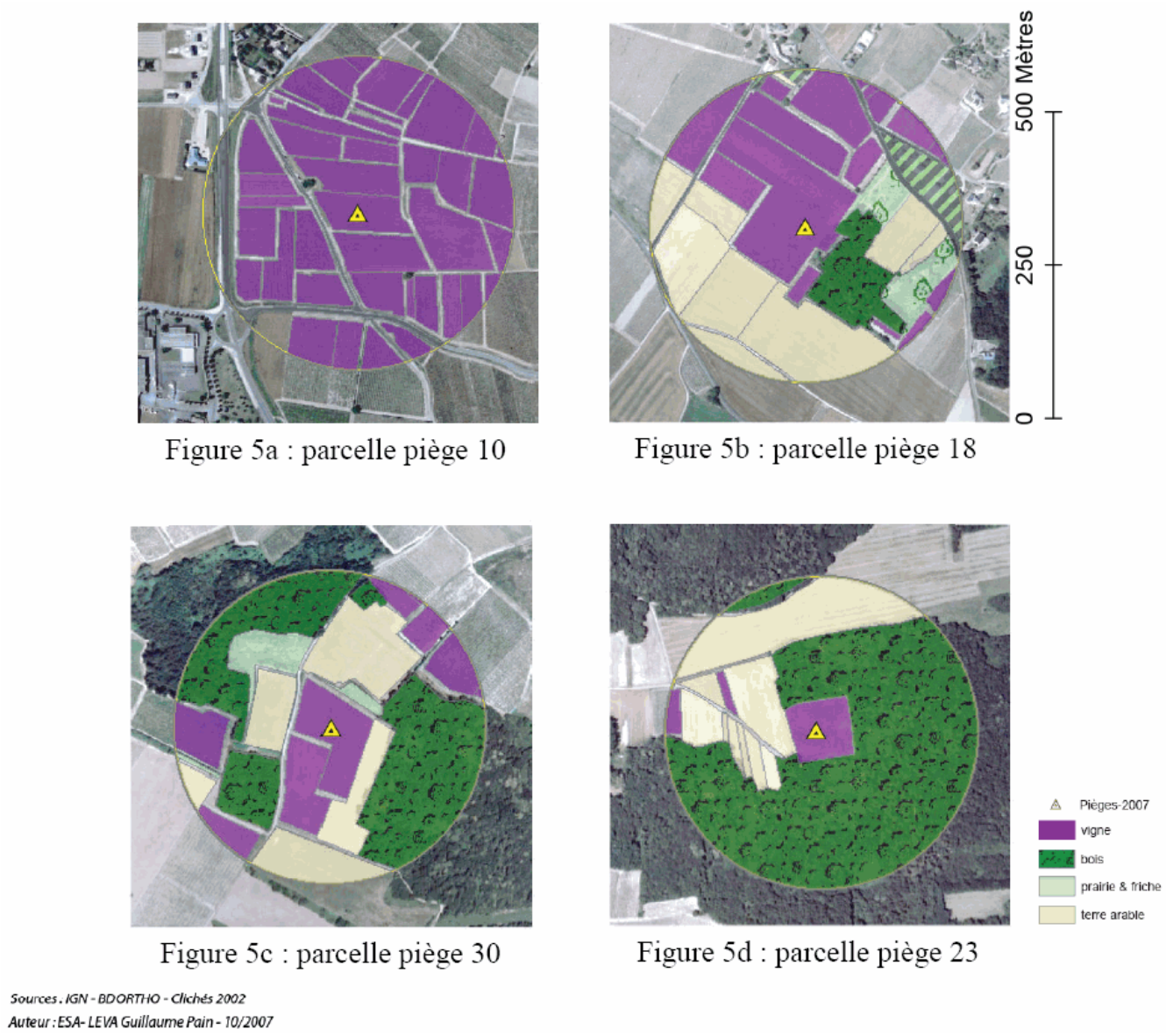

Figure 5a : parcelle piège 10

Figure 5b : parcelle piège 18

Figure 5c : parcelle piège 30

Figure 5d : parcelle piège 23

Figure 6 : description of the types of land cover in the neighbourhood of each trapping station, from aerial photographs, in a geographical information system and with a buffer of 250m radius.

3.3.3. Results

An analysis of the first three years of trapping in Saumur-Champigny AOC reveals that the four insect pests studied have very different distributions within the AOC, some being relatively evenly distributed while others favour certain areas (Figure 7). These distributions do not differ greatly between years.

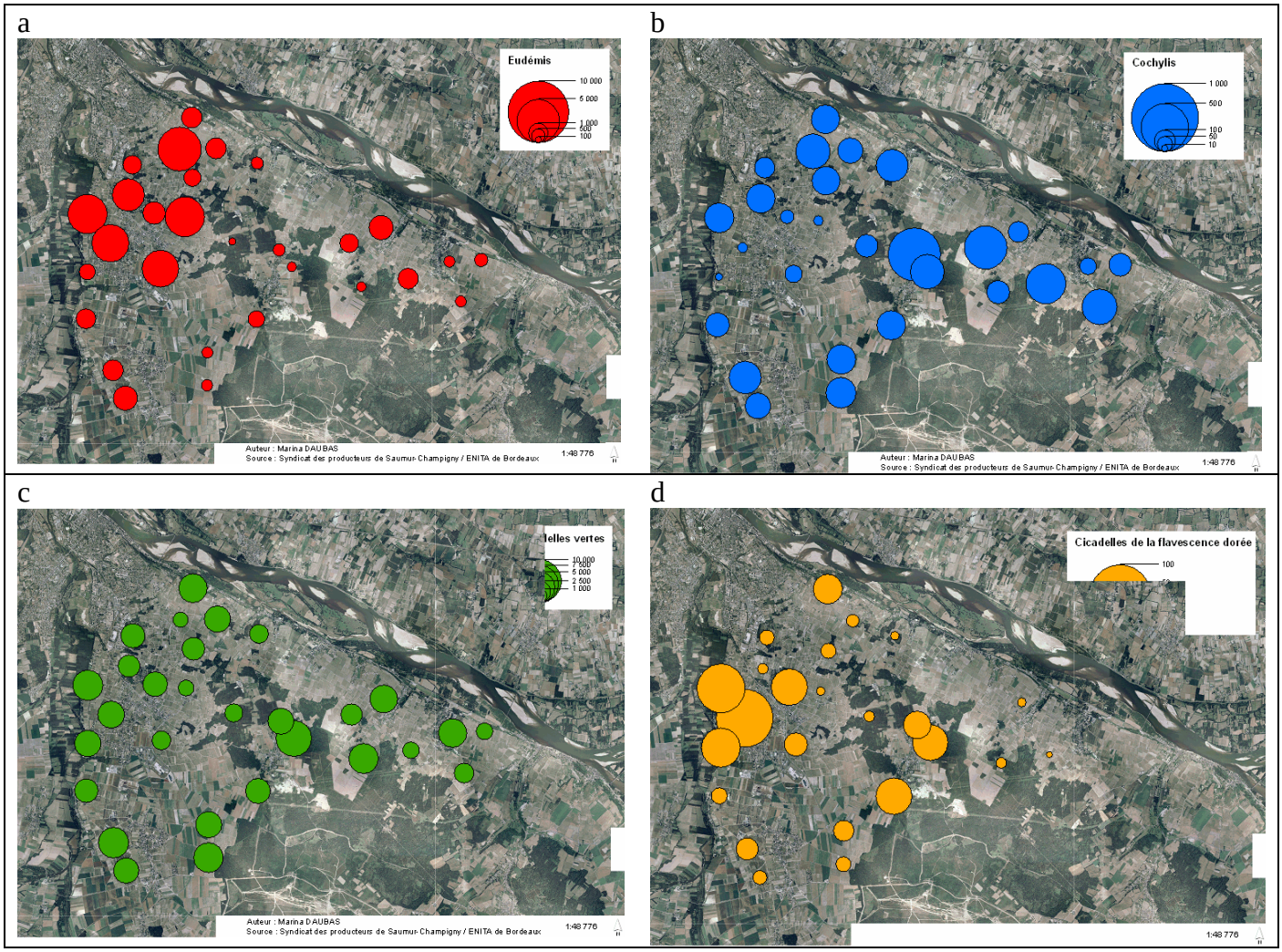

Figure 7 : cumulative pest numbers in 2005, 2006 and 2007. a. Grapevine moth, b. Grape berry moth, c. Vine leafhopper, d. *S. titanus* (source : Daumas, M. 2007)

Variations in the abundance of pests caught in traps may be partly explained by differences in landscape structure in the surroundings. The analysis of the correlation between landscape structure and numbers of different pest insects shows that:

- the highest densities of *L.botrana* are found in vine-dominated areas (large homogeneous monocultures) while
- the highest densities of *E. vitis* are more often associated with heterogeneous areas containing semi-natural habitats of value to biodiversity and
- no significant relationship can be found between the numbers of *E. ambiguella* and *S. titanus* and the type of land cover surrounding the traps

These initial results have been confirmed by other studies conducted by the ENITA Bordeaux team in other wine-growing areas. It would therefore seem that neighbouring landscape structure can influence pest pressure on vineyards. This confirms the relevance of landscape-scale approaches to conservation biological control.

However, not all pest species respond in the same way to variation in landscape structure:

- some pests, like *L. botrana*, seem to "prefer" areas of vine monoculture, and therefore it would seem necessary to increase landscape heterogeneity by creating areas or strips of semi-natural vegetation, to limit their spread;
- conversely, other pests, like *E. vitis*, seem to occur more often in diverse landscape contexts such that their spread might be encouraged by action taken to limit the first type of species.

In the Saumur-Champigny AOC, *L.botrana* causes potentially more damage than *E. vitis*. Therefore action is oriented towards increasing landscape heterogeneity, which enhances biodiversity more generally and may limit numbers of *L.botrana.* Care is taken to avoid plants that are suitable for *E. vitis* (for example Juniper) when creating new habitats. Moreover, the trapping continues, enabling effects of habitat creation to be monitored and to check that action taken does not encourage one pest while aiming to control another.

Noteworthy:
- landscape structure seems to have an effect on the numbers of pests in vineyards
- different species « do not respond in the same way » to landscape structure
- it is important to monitor pest populations given the uncertainty surrounding the effects of habitat creation on biodiversity
- it is important to monitor pests in order to involve wine-growers and provide them with warning newsletters that can help them to improve their pesticide use strategies
- there is a need now to assess how this project may have contributed to a reduction in the use of pesticides
- finer scale analysis of the landscape structure of the AOC is being carried out to improve our understanding of the mechanisms involved

3.4. Habitat creation plan

Right from the start of the project, the viticulturists wanted to use uncropped areas of the AOC to encourage biodiversity in the vineyards as a whole and to achieve a "balance of nature" that would contribute to vine pest control. The hypothesis that is central to their entire project is that "an increase in biodiversity will have a regulatory effect on pest populations".
In order to achieve this, the union tries to plant hedges, where possible, in places where there is no need to pull out vines or to rearrange field boundaries, i.e. on existing field edges, alongside walls, on banks or roadsides.
The plant species used are local and are chosen according to the final vegetation height required. In order to respect the wine-growers' needs and to avoid competition with vines, the hedges planted are usually low, or even low-spreading.

During the first years (from 2006 to 2008), the plantations were carried out by volunteer viticulturists, in areas they had chosen themselves (over 8 km were planted during this period, by 30 viticulturists).

In 2008, a habitat creation plan was drawn up to identify priority areas for planting to make more ecological sense and also to boost the unions' involvement in inciting wine-growers to plant. These landscape alterations are at the very heart of the project. If one is to measure the effects on pests and/or biodiversity, they need to be carried out in a coherent manner, to be sufficient in length (20-30 km) and rapid (2-3 years maximum).

3.4.1. Proposal for a logical sequence of action, from the researchers accompanying the project

Based on data collected in the AOC over the previous 3 years of the project, relating to land cover and spatial distributions of vine pests (cf. previous paragraph), the scientists accompanying the project suggested a simple approach based on three main principles, used as three working hypotheses (Box 1), which enabled clear general objectives to be formulated (Box 2).

Box 1: General principles and working hypotheses used to define the objectives of the Saumur-Champigny AOC habitat creation plan

Reduce homogeneity within the vineyard
- farmland homogeneity is a major cause of low biodiversity
- farmland homogeneity encourages outbreaks of pest organisms

→ Hypothesis 1: a reduction in this homogeneity is one way to encourage biodiversity and to limit pest outbreaks

*

Increase, where possible, the area of semi-natural habitats
- the larger the patch, the more species are found
- the larger the patch, the greater the chances of survival for the populations that live there

→ Hypothesis 2: the larger the area of semi-natural habitats, the more biodiversity they will support

*

Reduce isolation between semi-natural habitats (increase the connectivity between fragments of semi-natural habitat)
- when a species' habitat is fragmented, encouraging connections and the flow of individuals between habitat fragments can increase its chances of survival at landscape scale
→ Hypothesis: the less isolated semi-natural habitats are, the more biodiversity they will support

Box 2: the objectives of the Saumur-Champigny AOC habitat creation plan, in the form of a logical sequence of action

→ break up the uniformity of large areas of continuous vine

→ introduce heterogeneity into these areas through the creation of semi-natural habitats (Ecological Compensation Areas)

→ introduce, where possible, « patches » of semi-natural habitat, as large as possible, for example by extending existing fragments (value of « older » habitats)

→ where possible, connect fragments using linear features or stepping stones

→ the many small habitats created should be perceived as a network, integrating, or connecting the largest semi-natural habitats

In order to transform these objectives into practical advice, we firstly identified large areas of vine within the AOC. These islands of continuous vine corresponded to groups of very closely packed or neighbouring vineyards. 14 such areas were found which covered 97% of the vines and each measured more than 10ha (Figure 8).

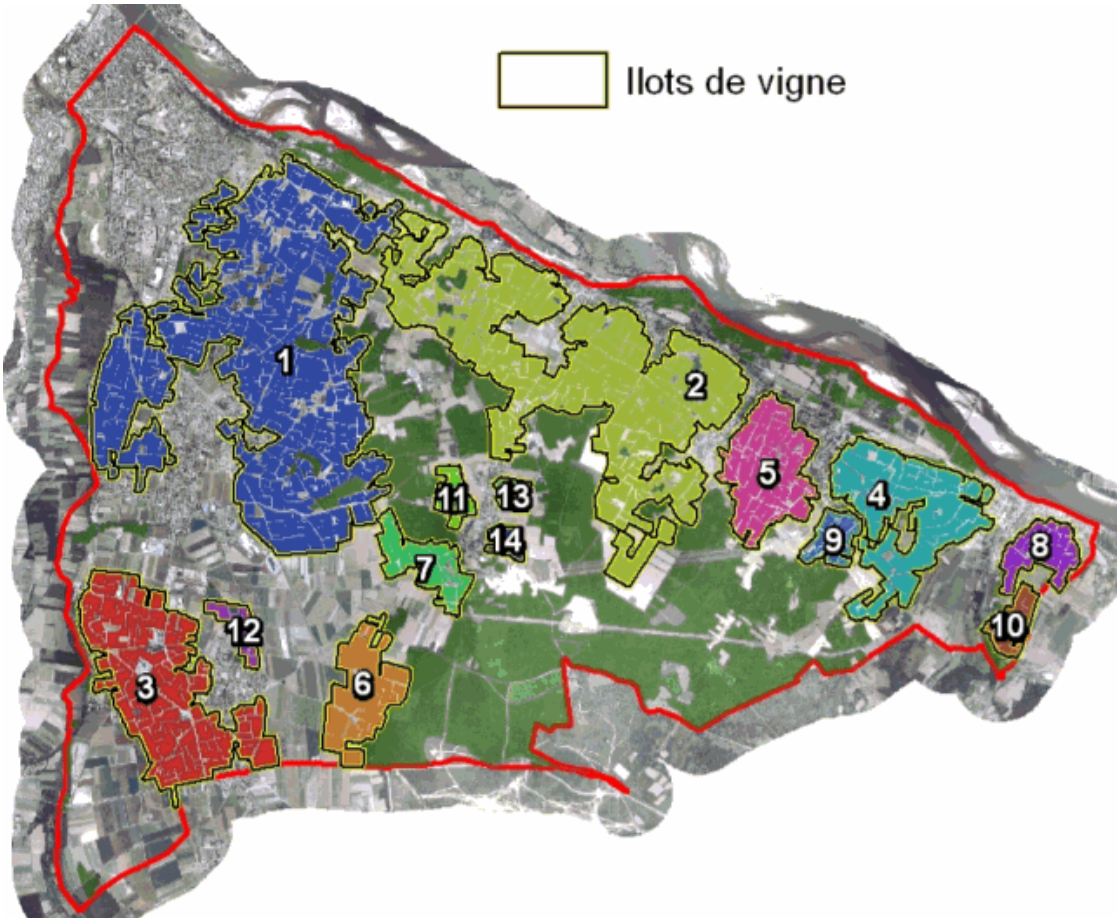

Figure 8: Distribution of vineyards within the Saumur-Champigny AOC. 14 islands are defined, which are groups of neighbouring vineyards.

The second step was to locate, within these islands, areas with relatively high homogeneity. For this, we considered those areas most isolated from non-vine habitat, a potential source of biodiversity, to be the most homogeneous. In view of the characteristics of the zone and of the available knowledge, we initially based our analysis on wooded areas, locating those vine islands that were more than 400m from a wood of at least half a hectare in area (Figure 9).

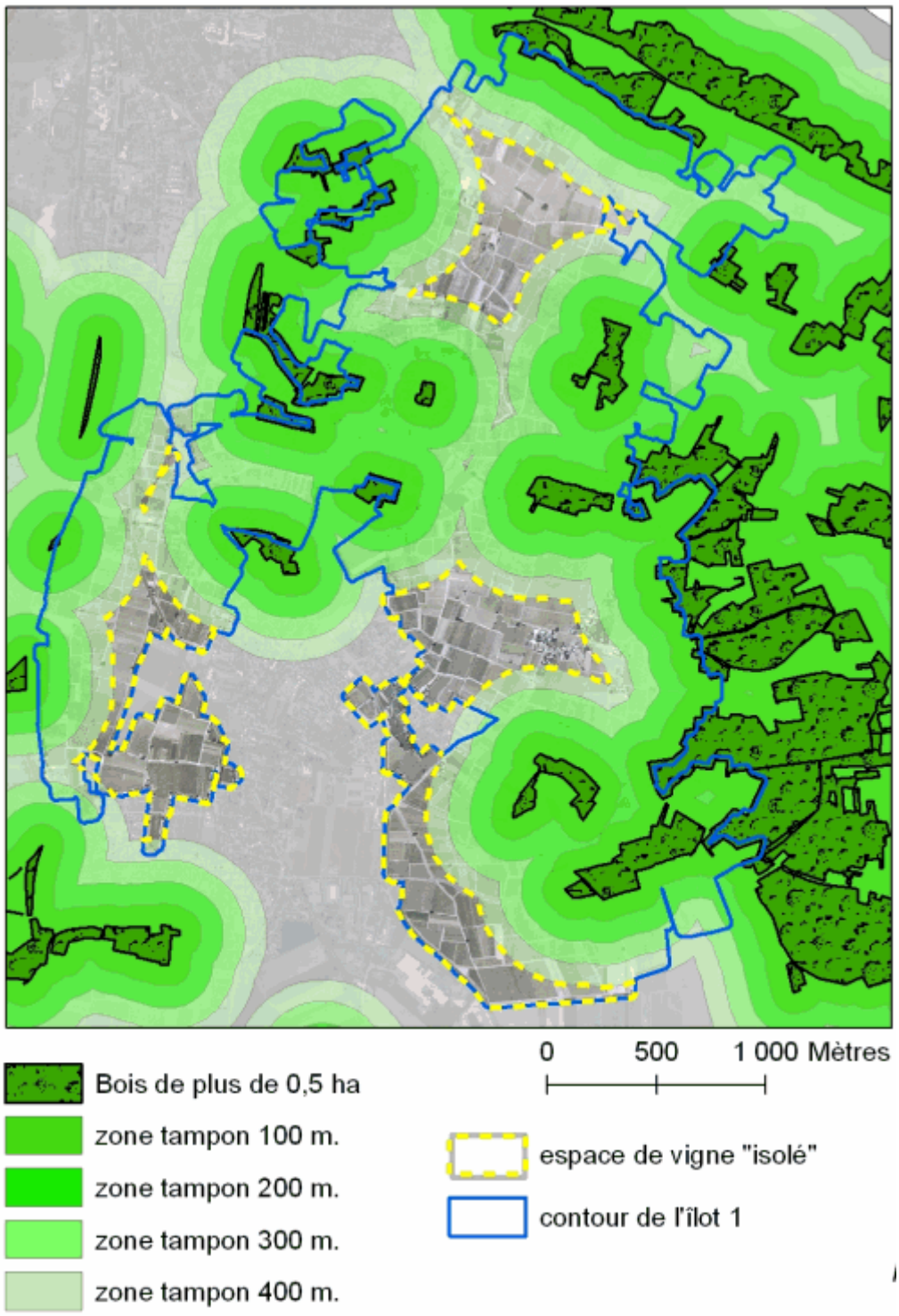

Figure 9: Location of areas of vine that were distant from semi-natural woods and considered to be homogeneous vineyard. Within each island (blue perimeter), areas of vine situated more than 400m from a wood were located using buffers drawn around woodland habitats.

Each of these areas may be considered to be a coherent unit for habitat creation within which the union can carry out specific action in collaboration with the group of viticulturists concerned.

The suggestion is that action to increase heterogeneity should be a priority in these areas, which represent more than 25% of the total area of the islands. To achieve this, taking into consideration the objectives cited previously, a survey should be made of:

- semi-natural habitats present, to assess the possibilities for increasing their size or improving their quality;
- uncropped areas with the potential to be planted, to suggest to their managers the planting of woody, perennial vegetation.

Some isolated areas contain smaller woods of less than half a hectare, which could be extended, while others contain a large network of banks, stone walls or roadsides which may be easier to plant.

3.4.2. Action in the field by the union and its partners

Based on this work, the union's coordinator defined 10 action areas within which she always took a similar approach (Figure 10).

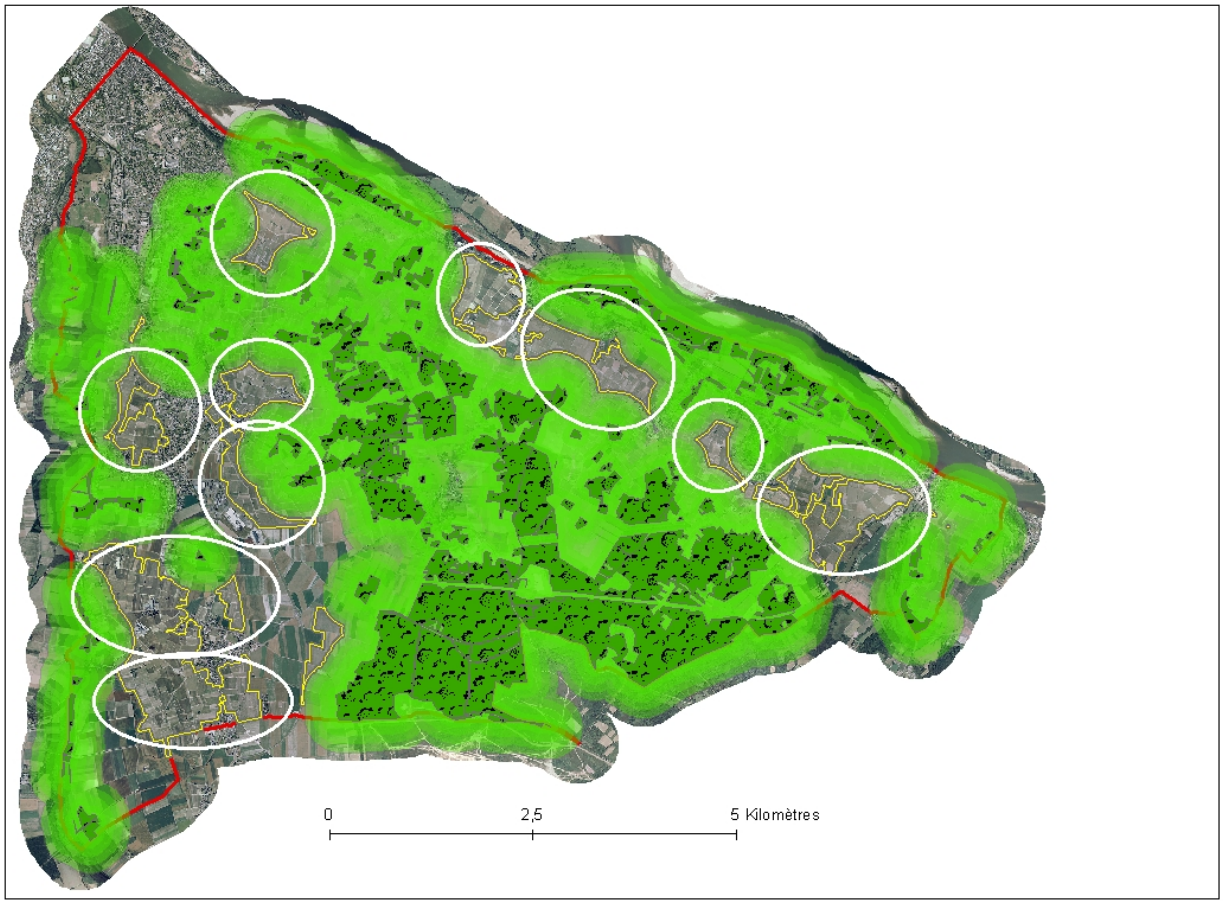

Figure 10 : Areas of vine distant from woodlands and considered to be isolated from potential sources of biodiversity (yellow perimeter) and the 10 action areas within which habitat creation projects are planned and suggested to wine-growers (white ovals).

In each action area, a field visit is carried out by the union's coordinator to survey the uncropped areas potentially suitable for planting. Based on this information, a habitat creation strategy is drawn up for

each area, taking into account the configuration of existing semi-natural habitats and opportunities for planting observed in the field.
In agreement with the scientific partners, two types of habitat creation strategy were used (Figure 11):

- a strategy concentrating on the creation of corridors between existing semi-natural areas; these vegetation strips could increase landscape connectivity for a collection of species and/or act as a barrier to field-to-field dispersal of flying insects;
- a strategy concentrating on the creation or extension of unconnected semi-natural areas

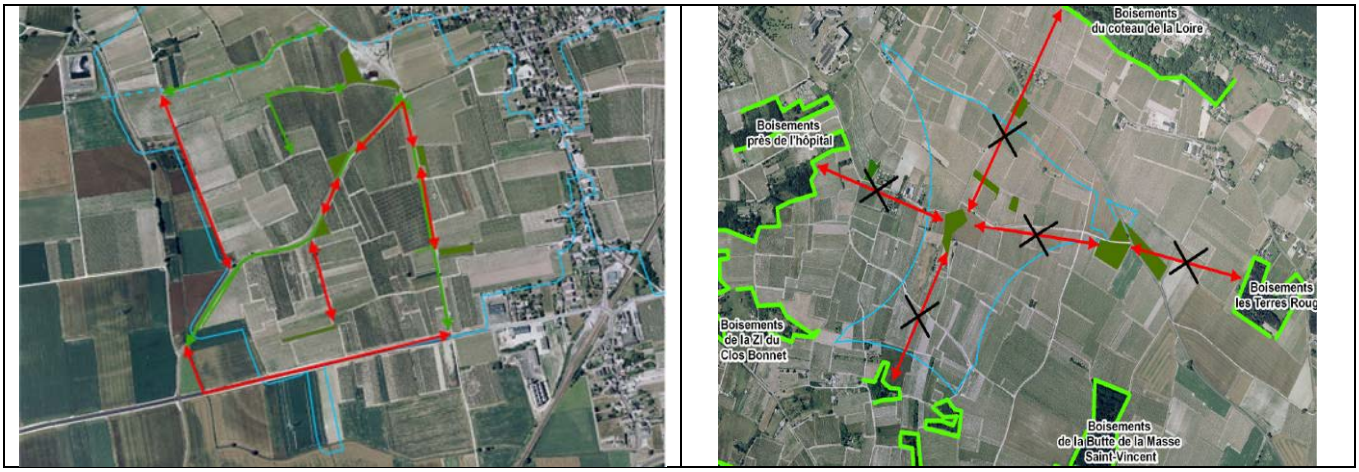

Figure 11: Two examples of habitat creation plans within two different action areas. On the left, the objective is to create a network of corridors between the vines. On the right, the objective is not only to create corridors, but also to maintain and extend areas of wood, or of scrub.

After this initial work, meetings are held to identify wine-growers that manage areas with a potential to be planted or extended. A field visit is arranged with each of these, in the presence of a technical advisor from the chamber of agriculture. If the wine-grower agrees to plant, a form is filled containing all the necessary information about location, type of habitat to be created and the list of plants needed.

The information from all of the viticulturists' planting projects is gathered together each season to enable the union and the chamber of agriculture to manage the provision of plants for each project.

Alongside the work carried out with wine-growers, information meetings are also organised in the communes and for certain local businesses, in order to try to encourage other organisations or individuals to participate by planting on the land they manage.

3.4.3. Results

The first three years of planting involved around thirty viticulturists who planted approximately 8 km of hedges. In the first year of implementation of the habitat creation plan (winter 2008-9), along with the coordination activities presented above, 47 viticulturists planted over 6.5 km in 4 of the action areas. In the winter of 2009-2010 the total length of habitat created had reached 20 km (Table 1).

Table 1: Length of hedge planted each year, in Saumur Champigny AOC, since the beginning of the project.

Year	Metres of hedge planted	
2005-2006	2232	8 381 m. before the habitat creation plan was implemented
2006-2007	2171	
2007-2008	3978	
2008-2009	6912	15 202 m. since the habitat creation plan has been implemented
2009-2010	8290	
	Total = 23 583	

Most of the hedges are low and bushy, growing to a height of 2 metres (Figure 12) or low crawling vegetation. A few hedges of trees or lines of fruit trees have been planted as well as one or two small woods.

Three communes have also taken part, planting a total of 550 metres of hedge, as have one business (60 metres) and one private individual (100 metres).

Figure 12: Examples of hedges planted in the context of the Saumur-Champigny AOC project (photos : Marie-Anne Simonneau).

Noteworthy:
- the definition of a habitat creation plan for the vineyard taking a simple approach, based on major principles taken from the scientific literature, making it possible to discuss the logic with the wine-growers
- the project's success in terms of metres of uncropped areas that have been planted
- the existence of areas suitable for planting within the vineyard
- the choice of plants of suitable height to meet viticulturists' needs (low hedges or spreading vegetation)
- the participation of other local organisations and individuals – planting hedges on local authority land or on private land not used for viticulture

4. Conclusion and discussion

This project is interesting for a number of reasons. To begin with, it is the first « agroecological » habitat creation project to be planned and implemented over an entire wine appellation area. As far as we know, no other project of its kind covers such a large area (1600ha of AOC vines in an area of over 60 km^2) or involves so many participants (over 50 planters).
Another originality of the project is that the wine-growers themselves were the initiators. Through their union, they organised themselves, sought out partnerships and completed requests for funding. The fact that the project was conceived by a union has influenced the definition of its content. As a result, the economic dimension is present throughout, with the aims of reducing pesticide use and therefore the cost of treatments, as well as the improvement of the commercial image of the appellation wines.
The project is an excellent tool for communication, which the union has made good use of through press or television (national news programme) coverage, the development of tourism with for example guided tours of the wine-growing area, its landscapes and the biodiversity project, or via temporary exhibitions…This short-term use of the project has enabled the wine-growers to have an immediate return on investment which has helped to compensate for the uncertainty surrounding the real medium and long-term effects of the new habitats. Many of the wine-growers also consider this project to be a fine example of viticulturists working together which has helped to improve group ties.
Finally, this project is also remarkable for the relationships it has established with scientists and the type of research they conduct. The very existence of the project is due, in part, to discussions between a few wine-growers and the Bordeaux team working on crop protection. And, as the project has progressed, the Angers and Bordeaux research teams have helped the wine-growers to construct their project, to design pest monitoring tools, to produce their habitat creation strategy. This partnership, which is a form of support to the wine-growers rather than a paid service or a research project of limited duration, is particularly valuable. The style of this relationship has enabled the wine-growers to construct a project that meets their needs, while allowing researchers to set up study protocols at landscape scale and to share their working hypotheses with the wine-growers.

This « biodiversity and landscape » project, based on the hypothesis that « increasing biodiversity has a regulatory effect on pest populations » and coordinated by a wine-growers' union, raises many questions, some of them ecological, others sociological and agronomical. Alongside the work presented here, a multi-disciplinary research project, coordinated by the Angers Landscape Research Unit and financed by the French ministry for the environment, is currently in progress. This research project is looking at:

- how the project emerged, the wine-growers' perception of biodiversity and how the project can be integrated at regional level;
- ordinary biodiversity, in particular the study of plants and birds found in the vineyard
- the structure of wine farms and the management of uncropped areas by viticulturists
- the landscape structure of the AOC and its development through time

Preliminary results confirm the importance of taking an interest in uncropped areas or interstices within the vineyard, if one is to understand the contribution wine-growers can make to preserving biodiversity. This adds more weight to the argument for landscape-scale approaches when studying the management of the sustainability of viticulture.

Références

Blondel J. 2005 Biodiversité et sciences de la nature *in* Marty P., Vivien F.-D., Lepart J., Larrère R. *Les biodiversités : objets, théories, pratiques.* CNRS Editions pp 23-36.

Boller E.F. (2006). Functional biodiversity : A success story in vineyards of Northern Switzerland. Landscape Management for Functional Biodiversity. *IOBC/WPRS bulletin.* Vol. 29 (6). p 13-16

Corbett A & Rosenheim J.A. (1996). Impact of a natural enemy overwintering refuge and its interaction with the surrounding landscape. *Ecological entomology*. Vol. 21. p 155-164

Daane K.M. & Costello M.J. (1998). Can cover crops reduce leafhopper abundance in vineyards?. *California Agriculture*. Vol.52. p 27-33.

Daumas, M. (2007). Influence du paysage sur les ravageurs de la vigne sur l'appellation Saumur-Champigny. Rapport de Master2. ENITA de Bordeaux, Université Bordeaux 1. 32 pp.

English-Loeb G., Rhainds M., Martinson T., Ugine T. (2003). Influence of flowering cover crops on *Anagrus* parasitoids (Hymenoptera: Mymaridae) and Erythroneura leafhoppers (Homoptera: Cicadellidae) in New York vineyards. *Agricultural and Forest Entomology*. Vol. 5. p 173-181

Le Roux X., Barbault R., Baudry J., Burel F., Doussan I., Garnier E., Herzog F., Lavorel S., Lifran R., Roger-Estrade J., Sarthou J.P., Trommetter M. (éditeurs) (2008). *Agriculture et biodiversité. Valoriser les synergies*. Expertise scientifique collective, synthèse du rapport, INRA, (France). (http://www.inra.fr/l_institut/expertise/agriculture_et_biodiversité__1)

Millennium Ecosystem Assessment, (2005). *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC

Nicholls C.I., Parrella M., Altieri M.A. (2001).The effects of vegetational corridor on the abundance and dispersal of insect biodiversity within a northern California organic vineyard. *Landscape Ecology*. Vol. 16: p 133-146

Van Helden M., Decante D., Papura D. (2003). Possibilities for conservation biological control against grape pests in the Bordeaux region. IOBC/wprs bulletin. Vol.26(4): 191-196.