PARC NATUREL RÉGIONAL DES **CAPS ET MARAIS D'OPALE**

December 2015

Scientific & Naturalist Notes

species

habitats

corridors

Parc naturel régional des Caps et Marais d'Opale

* New Life Emerges Here

Une autre vie s'invente ici *

Table of Contents

Layout and Graphics: Béatrice Garnier/Biotope. Cover photos credits: François Mulet. Damier de la succise : Thomas Luzzato/Biotope

editorial

A dream comes true... With this publication, the Caps & Marais d'Opale Regional Natural Park governing body publishes its first scientific and naturalist technical notes, and we are proud of it!

The preservation of biodiversity is a priority clearly expressed in the 2012-2025 natural park charter. This goal may be unremarkable for a chartered *natural* park, but it is a necessary condition even more strongly felt within the Caps et Marais d'Opale Park limits, a territory which hosts 80% of the species biodiversity of Nord – Pas-de-Calais administrative region. The Park Charter and founding document stresses the importance of knowledge and scientific cataloguing, whether produced by trained professionals or by amateur naturalists.

In this respect, the park works closely with specialist groups within a rich network of structured partnerships. The Park's primary role as a coordinator within its territory is recognized by all partners, allowing it to articulate the contributions of the diverse groups to create specific synergies and leverage public and private actions for the preservation of the Park's biodiversity. At the same time the Park's governing body acts, as appropriate as a developer of new infrastructures, as a catalyst for innovation and as a promoter and educator.

I take the opportunity of this remarkable publication to express my gratitude to the naturalists whose daily efforts are a testament of their commitment to the preservation of our collective biodiversity, as well as to the many elected Park officials who are fully vested on behalf of nature and whose work allows us to move forward a little more each day.

I especially thank the scientists and technicians of organisations and associations who contributed to these technical notes as well as to those institutions whose financial support made this publication possible.

Beyond its contribution to the dissemination of knowledge, I hope this collection of essays will inspire new passions in some while convincing remaining sceptics —if there be any— of the importance of biodiversity in the Caps and Marais d'Opale territory.

Dominique REMBOTTE
President
Caps & Marais d'Opale Natural Park

editorial

By a curious paradox to which we have become accustomed, following several decades of disregard for university training and naturalist studies, field studies conducted by "amateurs" in the best sense of the term - meaning enthusiasts, most of whom work outside of the major research institutions - have never had it so good. The following articles confirm the scientific rigour with which the Caps et Marais d'Opale Natural Park approaches the study of Park lands. The studies enrich our understanding of the biodiversity of a few of the remarkable environments within the Park such as the chalky hills of Boulonnais or the Audomarois marshlands.

Biodiversity is in fashion, so much so that in spring 2010 - the United Nations International Year of Biodiversity - a TNSofres survey on behalf of the daily press revealed that 95% of all French people considered the preservation of biodiversity to be important, while only 23% were able to say what it was. Since the term was first used in 1986 at a North American conference on the diversity of life, it has become a catchall word for those who defend an idealized conception of Nature on the premise that "it was better before", as if to say that obviously, biodiversity could only be threatened and endangered.

To the credit of the Park and the authors, the pages that follow offer a tempered and scientifically accurate view of case studies, carefully removed from alarmist ecological, political and popular rhetoric. More impressive even than the knowledge provided or the questions raised, is the fact that these pages can be read as a tool for reflection on what exactly constitutes good land management.

We look forward to the next instalment.

Jacques COGET
Chairman of CSENPC
Scientific and Environmental Council Nord – Pas-de-Calais

introduction

The history of biodiversity conservation shows conceptual developments that may be understood in varying scales and in more or less "integrated" approaches to the protection of nature. We speak today of "conservation biology", a science which applies the principles of ecology, biogeography and landscape ecology along with population dynamics and genetics. From this perspective, the concept of a "green and blue" network of terrestrial and aquatic ecological continuities has evolved, particularly in Europe, beginning in the 1980s. Today the concept has become at once scientific, technical and political. Indeed, the fragmentation of ecological networks, a major threat to biodiversity, has significantly reduced population sizes by reducing the extent of habitat, in this way increasing isolation and reducing the probability of (re-)colonisation and species development.

To better understand these phenomena at the local level, improved knowledge of population dynamics is essential. In the Nord – Pas-de-Calais Region, our understanding of the environmental factors affecting our region has greatly improved, both from the standpoint of the quality and organisation of data collected and in terms of the implication of community actors.

In terms of assessing the scientific knowledge required to sustain biodiversity conservation, the role of the Regional Natural Park, Caps et Marais d'Opale, is to lead at times, and at others to experiment and observe while remaining a facilities manager, a partner and coordinator to civil society and a spokesperson for the naturalist community. These multiple roles, at once complementary and essential are supported by the European Regional Development Fund for Biodiversity, without which our efforts would not have met with the success they have.

As such, these scientific and naturalist notes represent a sampling of the work done by the park and its partners on a number of species, emblematic or little known, as well as habitats which are characteristic of the territory, with its lime rich soils and chalky slopes, its wetlands and examples of ecological corridors applied on different scales.

In terms of species, the monitoring results for the Marsh Fritillary (*Euphydryas aurinia*) which inhabits the chalky grasslands of Boulonnais and a preliminary inventory of lesser known species such as the ant show the importance of both improved knowledge and in-depth study of some species, sometimes indicators, sometimes vectors for connecting with a territory and for managing natural spaces.

With respect to habitats, it was decided to study the fungus kingdom of the chalky hills characteristic of the territory; as well as the marshes themselves with a detailed study of two herons emblematic of the park: the Great Bittern (*Botaurus stellaris*) and Little Bittern (*Ixobrychus minutus*).

Finally, the park's efforts to establish **ecological corridors** are explored at two different scales: a macroscopic scale presenting the results of a study of coastal avian migration along the Channel and the North Sea, and a study of the effects of ecological corridors in agricultural areas via a "field study".

We should recall that whatever approach one adopts, whether "species", "habitat" or "corridor", these are completely interdependent in the sense that biological connections can only be defined using species ecology (population demographics and movement) in relation to the habitat studied.

Other findings of a less scientific character perhaps but just as important for the reestablishment of green and blue ecological continuities are presented in the form of two practical works, one focused on the rescue of amphibians during breeding season, the other concerning the prevention and containment of invasive species as a strategy for the regulation of ecological equilibria and the maintenance of economic activities.

Each item proposes an identical template which first presents the context for study, the methodology adopted, conclusions and discussion.

Note to our readers:

These results are from observations, studies and field practices produced by Park naturalists partners and technicians. They are the product of scientific rigour, extensive field work and a wealth of naturalistic observations. Comments and suggestions for improving our efforts are welcomed and should be sent to info@parc-opale.fr.

Thank you to all the authors and contributors to this book.

species

habitats

corridors

Marsh Fritillary
Euphydryas aurinia
© M. Vilarelle

A study of the MARSH FRITILLARY *Euphydryas aurinia* on the Boulonnais chalky grasslands


M. VILARELLE[1]
G. REY[2]

Abstract: The “rediscovery” in 2012 of sites hosting the Marsh Fritillary, a butterfly species strictly protected by Annex II of the “Directive Habitat-Faune-Flore”, the Parc naturel régional des Caps et Marais d’Opale and the Conservatoire des Espaces Naturels (CEN) of the Nord – Pas-de-Calais Region commissioned a study focused on this species. The primary objectives of the study were to assess the distribution and abundance of Marsh Fritillary populations and to evaluate the conservation status of its chalk grasslands habitat.

A survey of the 24 hectares of calcareous grasslands on the north Boulonnais slope habitats, resulted in the discovery of two colonies of respectively 216 and 9 individuals observed at peak abundance in 2015. The Marsh Fritillary however, has disappeared from historical habitats charted by the Groupe Ornithologique et Naturaliste du Nord (GON) and followed by the Conservatoire des Espaces Naturels since 2012. A survey and evaluation of the Marsh Fritillary habitat, including habitat quality in terms of available space, species specific resources, available shelter and migratory corridors has contributed to identifying a number of priority sites for restoration and reintroduction, and a better understanding of the challenges posed by adaptive management. Beyond statistical results, the species remains in critical danger of extinction from this site and new measures are required for long term monitoring.

Keywords: Marsh Fritillary butterfly (*Euphydryas aurinia*), chalk downs, grasslands, Devil’s-bit Scabious (*Succisa pratensis*), habitat conservancy.

***Résumé** : Suite en 2012 à la « redécouverte » de sites abritant le Damier de la succise, espèce inscrite à l’annexe II de la Directive Habitat-Faune-Flore, le Parc naturel régional (PNR) des Caps et Marais d’Opale et le Conservatoire des Espaces Naturels du Nord – Pas-de-Calais (CEN) ont mené une étude ciblée sur cette espèce. Évaluer la distribution et l’abondance des populations ainsi que l’état de conservation des milieux de pelouses calcicoles favorables à cette espèce ont constitué les objectifs premiers de cette étude.*

Couvrant 24 hectares de pelouses calcicoles de la cuesta nord du Boulonnais, les prospections menées par le Parc ont donné lieu à l’identification de deux populations. Les sites historiques suivis par le Groupe Ornithologique et Naturaliste du Nord de la France (GON) avant 2012 puis par le CEN n’abritent, quant à eux, plus d’individus de Damier de la succise. L’analyse des milieux, de leur qualité en terme de ressource et d’abri, leur connectivité et leur surface a permis de mieux appréhender les enjeux que représente une gestion adaptée. Outre les résultats concluants obtenus, l’espèce garde un statut critique et un suivi à long terme, accompagnant les nouvelles mesures de gestion mises en œuvre, s’avère nécessaire.

***Mots-clés** : Damier de la succise (*Euphydryas aurinia*), Succise des prés (*Succisa pratensis*), pelouses calcicoles, gestion conservatoire.*

1. Parc naturel régional des Caps et Marais d’Opale (PNRCMO) – BP 22 – 62142 Colembert – mvilarelle@parc-opale.fr
2. Conservatoire des Espaces Naturels (CEN) – 152, boulevard de Paris 62190 Lillers – gaetan.rey@espaces-naturels.fr

An adult Marsh Fritillary foraging on a Ragwort. © M. Vilarelle

INTRODUCTION

Considered "remarkable habitat", chalky grasslands are semi-natural environments produced by agro-pastoral practices which combine extensive grazing with slash-and-burn techniques. Chalky grasslands constitute one of the principal biotopes of the Park. In fact, the Caps et Marais d'Opale Regional Natural Park hosts nearly 80% of the chalky grasslands of the Nord – Pas-de-Calais administrative territory. Today, the decline of chalky soil habitat reflects in part the abandonment of pastoral activities, which has led to colonisation and enclosure of the habitat by woody plants, but also the over amendment of poor soils, which is harmful to the oligotrophic natural cover (van Swaay & Warren, 2006). The combination of these factors has led to the disappearance of calcareous grasslands and fragmentation of remaining grasslands, with the resulting isolation of associated butterfly populations (Zimmermann *et al.*, 2011). Among these, some are now declining at a national or European scale and are approaching or have already achieved a "critical" conservation status. This is the case of the Marsh Fritillary (*Euphydryas aurinia* Rottembourg, 1775), a species of Community interest listed in Annex II to EU Directive Fauna-Flora-Habitat, and designated as Endangered (EN) by national and regional Red Lists (Haubreux & Hubert, 2014). The Marsh Fritillary is also listed as a priority species for the regional restoration plan (Hubert & Janczak, 2014).

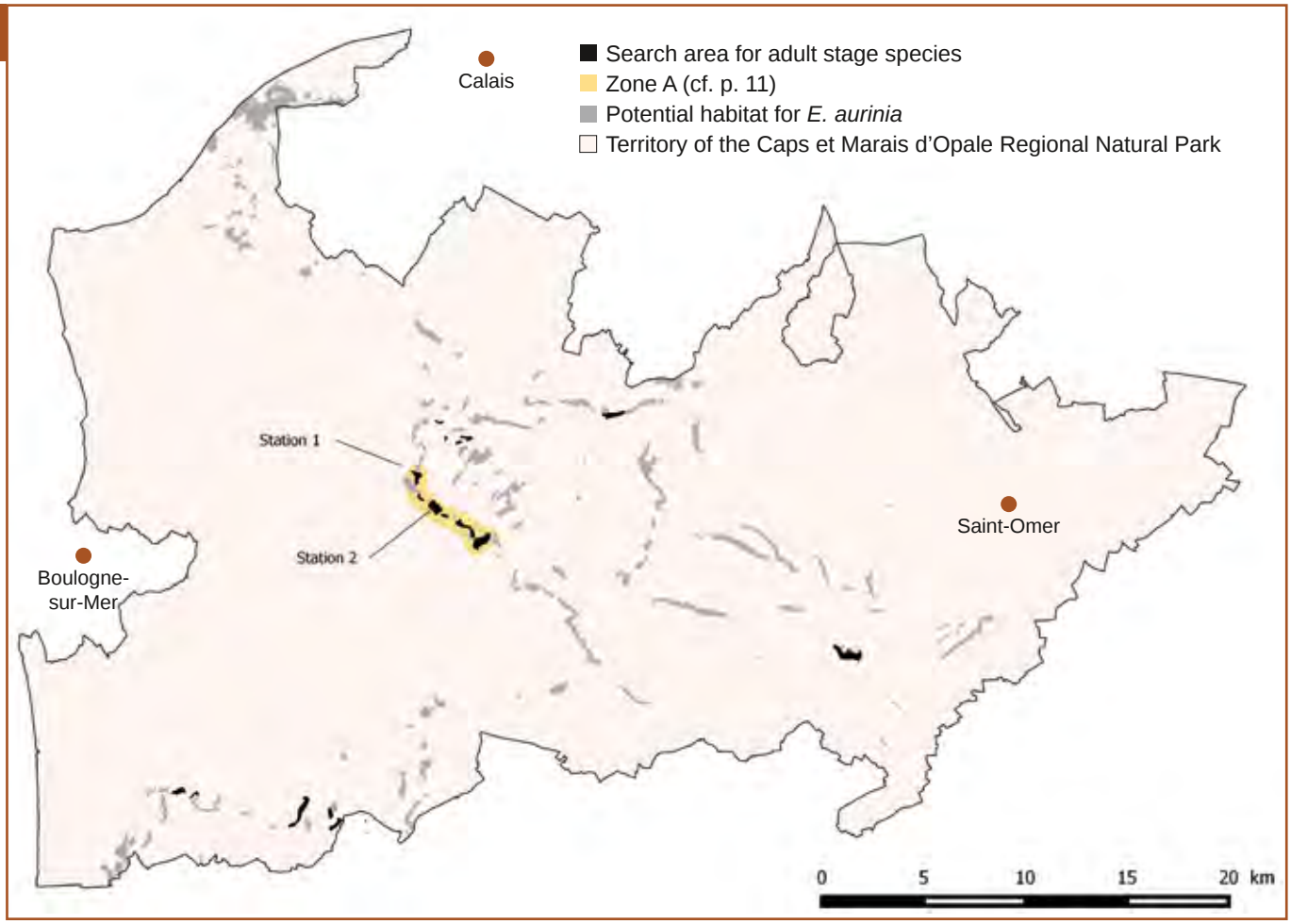
The Marsh Fritillary is ***particularly vulnerable to*** *habitat fragmentation*

Insect of the order Lepidoptera and of the Nymphalidae family, various studies have confirmed that the Marsh Fritillary **functions in metapopulations subject to natural cycles of extinction and expansion** (Warren, 1994; Hula *et al.* 2004), making it **particularly vulnerable to habitat disruption and isolation** (Smee *et al.*, 2010). This acute sensitivity has led to a 55% decline of its native habitat in Europe and more than 50% in France over the past 25 years (Bulman *et al.*, 2007).

SITE CONTEXT AND PRESENTATION

Within the limits of the Nord – Pas-de-Calais region, the species occurs in two distinct areas, with one population located in the Trelon forest southeast of

Map



Lille in the Avesnois district, and a second population among the chalky grassland of the Boulonnais. Mainly located on the south cuesta of the Boulonnais between 2000 and 2006, the species was "rediscovered" at two sites on the northern cuesta.

In 2001 the "National Programme for the Restoration and Conservation of Diurnal Lepidoptera", published by the OPIE (Office for Eco-Entomological Information) highlighted the lack of scientific information on the ecology of *Euphydryas aurinia* among the chalky grasslands of northern France (Dupont, 2001).

The first records of the species in the Boulonnais area date from sightings the late 1980s on the slopes of Wavrans-sur-l'Aa (1988 then 1999) and Clerques (1989), followed by sightings in Colembert (1995) and Nabringhen (2000). Between 2003 and 2006, it was observed on several chalky slopes of the cuesta south of Boulogne (Samer, 2003 to 2006; Verlincthun, 2004 and 2006; Parenty, 2005 and 2006; Lacres, 2005) and on the slopes of Dannes-Camiers in 2004 (Alderweireld *et al.*, 2014).

Sought and followed each year by the GON, the species had not been seen on Park territory since 2007. It was spotted again in 2012 on an isolated hillside not previously inventoried. Following the sighting, Caps et Marais d'Opale Regional Natural Park and the Conservatoire (the Conservatory for Natural Spaces, or "Nature Conservancy") who manage numerous chalky grasslands launched a study aimed at gathering new scientific knowledge that could be helpful for the conservation of the species. This approach resulted in the establishment of a monitoring protocol for one of the key areas in the Nord – Pas-de-Calais: the north cuesta of the Boulonnais territory. The new monitoring activity was staffed by the Park whereas historical spots were monitored by the CEN.

By focusing on known habitat, the monitoring protocol was designed to evaluate the number and extent of the Marsh Fritillary as well as habitat characteristics that favour its presence, in order to guide future efforts for the restoration of the chalky grasslands of the Boulonnais cuesta to meet species requirements. To meet this goal, we would attempt to ascertain:

- The distribution and abundance of species at different stages of the species' life cycle at the studied sites and whether populations live on or not;
- Environmental parameters and management practices favouring sustained presence for the species.

The protocols were drawn from the scientific literature and validated during working meetings involving all stakeholders in the region: GON, CEN, EDEN62 and personnel from the Caps et Marais d'Opale Regional Natural Park (RNP). In order to conduct the study, several adaptations were made to accommodate for available human resources and climate and weather conditions.

MATERIALS AND METHODS

The methods used for this study include research and monitoring of the adult (imago) and larval stages, an evaluation of habitat quality for each of the two sites currently inhabited and an evaluation of habitat potential of surrounding sites (Zone A). The evaluation protocols used by the CEN on the historical habitats being only slightly different from those used by the RNP, these are not described here (Alderweireld *et al.*, 2014).

MONITORING OF THE ADULT STAGE

Adult monitoring was conducted between mid-May and the end of June, throughout the adult flight period, that is from 10h30 to 17h00, when temperature and sunlight conditions are favourable (minimum temperature of 13 °C and 60% of sunshine and 17 °C and 40% sunshine) (Pollard & Yates, 1993).

Both stations where the Marsh Fritillary had been identified were studied and subjected to weekly monitoring by the RNP throughout the flight period. The CEN monitored stations within the historical habitat on three different occasions between May and June and the entire study area was assessed as many as three times each year to detect new presence sites. This monitoring was done by teams of eight to twelve observers recruited among local partners (CEN, GON, EDEN62), thus improving the efficacy of the half-day study.

In order to assess the number and distribution of populations without risk to individuals, we chose to use the Yates-Pollard method (Pollard 1977, 1982; Pollard & Yates 1993), by far the most common method for assessing species richness and abundance of butterfly populations (Nowicki *et al.*, 2008).

According to this methodology, an observer will follow a zigzag course along a given transect, counting the number of individuals observed within 5 metres ahead and 2.5 metres on either side, left and right. The length of the transect is proportional to the area of the site. From the results, a Pollard index is determined as the sum of the weekly averages (Pollard 1977, 1982; Thomas 1982). This index is intended to reflect the size of the total annual population (Pollard & Yates 1993), allowing observers to arrive at reliable estimates of a population's evolution.

Mating. © M. Vilarelle

MONITORING OF THE LARVAL STAGE

A count of species communal nests is made in the fall. This approach brings a different perspective to the study of a population's health by including information on reproductive success. When conducted thoroughly, it is a very effective means of making population estimates among breeding sites (Thomas & Simcox 1982).

Marsh Fritillary community nests are usually easy to spot in the vegetation, as they are installed on the stalks of *Succisa pratensis* (or Devil's-bit Scabious), whose purple flowers dominate the grasslands in September. The counting should be done during the period when the nests are woven relatively high on the stalk, before the caterpillar enters diapause and builds a "winter nest" lower down the stalk, usually at ground level. In general, and depending on the climatic peculiarities of the regions, the caterpillars appear in early July and enter diapause at the first winter cold (Goffart *et al.*, 2001). The most favourable time to detect nests therefore falls to the months of August and September. On a site scale, it is better to wait for the flowering of *Succisa pratensis* meadows.

Fowles & Smith (2006) suggest that below 25 breeding nests, a population can be considered in danger of extinction while Goffart and colleagues (2001) estimated that 10 nests represented a minimum threshold for population survival.

Good conditions	Grassy stands of between 12 and 25 cm with *Succisa pratensis* occurring in each square metre on 80% of the site. Overgrown plots (heights > 50 cm) should be limited to less than 5% of the total area
Favourable habitat (extensive grazing)	Areas in which stands of *Succisa pratensis* are present either occasionally or frequently and vegetation height exceeds 25 cm or where the height of the grasses is between 12 and 25 cm but where undergrowth coverage is greater than 5% of the habitat area
Favourable habitat (intensive grazing)	Fields in which *Succisa pratensis* is common or abundant, over-grazed or mown grasses (<12 cm)
Favourable habitat (sparse)	Fields in which *Succisa pratensis* is only occasionally or rarely present and the height of the vegetation is less than 25 cm
Potential habitat	Fields in which *Succisa pratensis* is rare and sparsely distributed, under-grazed or abandoned (> 25 cm)
Adverse habitat	All other habitat types

Table 1: Terms and classes defining the quality of habitat for the Marsh Fritillary (Fowles & Smith, 2006).

Each nest is then tagged by a GPS point in order to establish a precise mapping and spatial distribution of the species and thus identify areas important for reproduction which must be managed in a different way thereafter.

EVALUATING MARSH FRITILLARY HABITAT

The presence and the density of the Marsh Fritillary at the larval stage depend on factors which include availability of *Succisa pratensis* in the surrounding grasslands, the height of the grassy vegetation, the *Succisa pratensis* architecture, (Liu *et al.*, 2006; Botham *et al.*, 2010), the grasslands space's openness rate, the way of management, the size of the area, the connectivity (Bulman *et al.*, 2007) and the degree of direct sunlight (Anthes *et al.*, 2003). If the species is more "demanding" of the quality of its habitat at the larval stage, the quantity and quality of nectar producing plants is critical to ensure and sustain the presence of adults and should not be overlooked (Anthes *et al.*, 2003; Kramer *et al.*, 2012).

For each patch of chalky grasslands shown in Zone A, the abundance of *Succisa pratensis*, the height of the surrounding vegetation and the amount and degree of overgrowth were measured. In order to classify these sectors with respect to the *E. aurinia* habitat, the quality of habitats was evaluated using the guide established by Fowles in 2005. So that there would be no confusion in identifying *Succisa pratensis*, we conduct field surveys at the end of August, during the flowering period.

A Landscape Quality Index is then calculated (Fowles, 2005) from optimal, suboptimal and favourable habitat areas based on the area of the surveyed landscape.

During the flight season each site was evaluated in terms of plants foraged for nectar and the density of the various plant species pollinated by the Marsh Fritillary by counting the number of inflorescences within twenty 1 m² plots in a Z-shaped transect (Fowles, pers. comm.).

In order to better comprehend the impact of habitat features and management methods, a Hill-Smith analysis is made of the effects of each variable considered.

RESULTS AND DISCUSSION

STUDY OF THE ADULT STAGE

The study conducted in 2013 confirmed the presence of the Marsh Fritillary on two plots in the north cuesta of the Boulonnais (Vilarelle, 2013). These two populations have been found every year since. In the context of collective surveys, no new stations have been discovered (Vilarelle, 2014). Follow-up monitoring of the historical stations carried out by the CEN indicated that the species were absent from these stations (Alderweireld *et al.*, 2014).

Populations (figures 1 and 2, table 2)

Station 1 presents peak numbers observed, between 84 and 216 individuals. Since 2013, these figures have increased along with the calculated Pollard index. Station 2 presents much reduced numbers whether in terms of individuals observed at peak viewing or according to the Pollard index. Moreover, these numbers have been declining for three years.

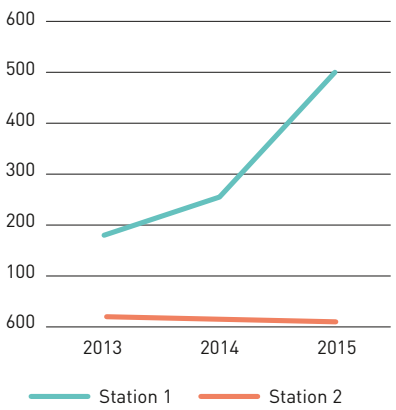


Figure 1: Changes in the Pollard index

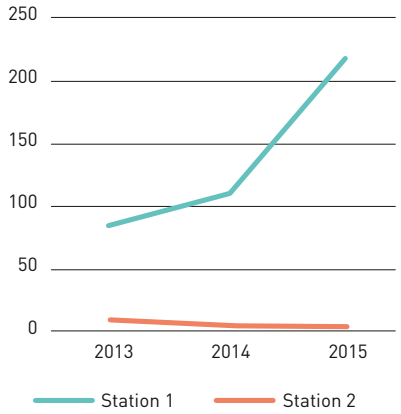


Figure 2: Changes in peak annual observation

	Week										Pollard index
	18	19	20	21	22	23	24	25	26	27	
Station 1 2013	0	0	0	0	3	43	45	84	5	1	181
Station 1 2014	0	2	100	111	33	11	0	0	0	0	257
Station 1 2015	0	0	5	98	134	216	31	14	4	0	502
Station 2 2013	0	0	0	0	4	9	1	0	0	0	14
Station 2 2014	0	1	6	3	0	0	0	0	0	0	10
Station 2 2015	0	0	1	3	0	0	0	0	0	0	4

Table 2: Population assessment using the Pollard Index (sum of weekly observations)

Local phenology

With respect to the phenology of the species between 2013, 2014 and 2015, there was considerable variation year-on-year and significant contrast between the two observing stations. In 2013, the first adults were observed toward the end of May, approximately two weeks later than usual. In 2014 and 2015, by contrast, the mild spring weather conditions caused them to emerge early, from early to mid-May (figure 3, table 2).

On station 1, adults were observed flying throughout the course of one month, an activity that corresponds to the species norm. At station 2 however, adults were observed on fewer than 15 days after the first emerging.

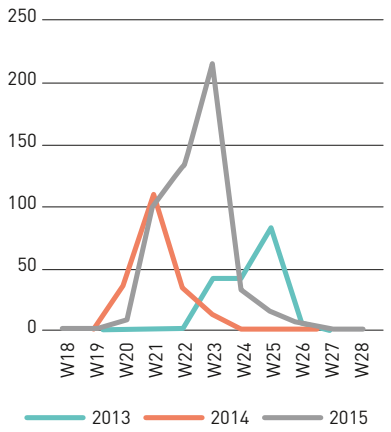


Figure 3: Numbers observed at station 1

STUDY AT THE LARVAL STAGE

In 2013, an inventory census was undertaken by three individuals on September 3 (table 3). At this time, 12 nests were found at station 1, corresponding to approximately 350 individuals (Anthes *et al.*, 2003). No nests were found on station 2. These nests are located in areas with *Brachypodium pinnatum* (tor-grass); they are diffuse, often large (> 10 cm) and placed high within the vegetation which corresponds to a correct larval stage in conducting the surveys.

In 2014, despite three census events between August 20 and October 20, and a team of 2 to 4 observers, no nests were observed at station 2 while at station 1 a single, small nest (<5 cm) was found buried in the vegetation at ground level. All observed nests were found at the base of *Succisa pratensis* and it was possible to observe the larvae feeding on the host plant leaves. As a result of the remnants of nest webbing we were able to observe how nests migrate from one stalk to another once the leaves of the first stalk had been fully consumed. In 2013 solitary caterpillars were also observed in April, feeding on the *Succisa* leaves.

Station/Year	2013	2014
Station 1	12	1
Station 2	0	0

Table 3: Number of recorded nests at stations 1 and 2

A community nest, *Euphydryas aurinia*. © M. Vilarelle

A Marsh Fritillary chrysalis. © M. Vilarelle

EVALUATION OF HABITAT QUALITY IN SUPPORT OF THE MARSH FRITILLARY

Of the 23.9 hectares of chalky grass and borderlands, 22.4 hectares were mapped as potential habitat for the

An adult stage Marsh Fritillary poised on vegetation. June 2013. © M. Vilarelle

Marsh Fritillary based on the presence of host plants. Only 4.8 hectares were classified as Good Conditions (GC). The remaining 17.6 hectares were classified by their less favourable plant structure and/or host plant density. The landscape quality index for Marsh Fritillary in the northern cuesta area of the Boulonnais was determined to be 87.11.

Important factors for the presence of the species at the local level

A Hill-Smith analysis showed conclusively that the presence of the Marsh Fritillary is positively linked to the abundance of nectar sources, as well as access to meadows rich in *Succisa Pratensis*.

Similarly, it was determined that grasslands managed by sheep grazing, or by intensive grazing were poor in *Succisa pratensis*.

DISCUSSION

The 2013 study confirmed the presence of the Marsh Fritillary on two plots in the north cuesta of the Boulonnais. These two populations were found every year since. In the context of these collective surveys, no new stations were discovered. The known stations are located at 1600 m from each other, a distance which could be easily covered by an adult in a dispersion event, and one might envisage exchanges between these two populations.

For the surveyed sites, it is not possible to say whether the failure to observe adults was tantamount to saying that the species was absent from the site. However, the surveys completed throughout the study area during the adult flight period and under favourable conditions (sunlight, wind and temperatures) led us to suspect that these sites were no longer breeding sites. Such sites may of course be repopulated at any time on the occasion of a dispersal event.

The entire study area represents approximately 20% of chalky grasslands within Park limits. Although these habitats are the subject of many different surveys as part of different studies, one can easily imagine that the species is present elsewhere on the cuesta but that it simply has not been observed because of its short flight time or perhaps because of a lack of investigation.

With a peak observation in 2015 of 216 individuals on the north cuesta area of the Boulonnais, this monitoring confirms the leading role of chalky soils of the Boulonnais for the preservation of the Marsh Fritillary in the Nord – Pas-de-Calais administrative region. Ad hoc surveys in the Trelon Forest of the Avesnois district, an area south and east of Lille known to house a population of Marsh Fritillaries, reported peak observations of only 132 individuals in 2015 (T. Dhellemes, pers. comm.). At other stations known to have hosted metapopulations of the Marsh Fritillary between 2000 and 2010, no individuals were found (Alderweireld *et al.*, 2014). The Boulonnais cuesta seems to represent a last stronghold for the species in the Nord – Pas-de-Calais region.

The ecological carrying capacity of the cuesta with respect to the Marsh Fritillary has been estimated at 90 individuals per hectare (Zimmermann *et al.*, 2011). The 2015 population count for station 1 (1.87 ha) would thus place the metapopulations at or near peak capacity with more than 115 individuals per hectare at peak abundance. One can thus hypothesize that in 2015, individuals dispersed to find new breeding sites. Such a hypothesis should be tempered in view of the fragmentation and increasing isolation of suitable habitats.

A solitary Marsh Fritillary caterpillar. © M. Vilarelle

The Pollard-Yates method was chosen as a basis for a long term monitoring programme for the Marsh Fritillary. Indeed, as the observer effect on population numbers is negligible and has been controlled through standardized sampling practices (Nowicki *et al.*, 2008), future observations may be compared year-on-year in measuring population trends. This method is also known for providing more precise population variation estimates than the capture, mark, release and recapture method (Williams *et al.*, 2002). When the residence time of the species is about one week, the Pollard-Yates abundance index may correlate with actual population numbers (Nowicki, 2005). The period of residence for the Marsh Fritillary is relatively invariable and is estimated at 6.5 days (Goffart *et al.*, 2001; Simon, 2007). Thus, the Pollard index for the Marsh Fritillary could be correlated to the actual size of the population, making the size of the population in 2015 approximately 502 individuals.

Regarding the larval stage, nutritional observations were obtained exclusively on *Succisa pratensis*. This suggests that this species alone hosts the Marsh Fritillary in the Boulonnais district, despite the presence of the Field Scabious (*Knautia arvensis*) and the Pigeon Scabious (*Scabiosa columbaria*) that are sometimes used as host plants by the species in other regions (pers. comm. CEN Picardie). The low number of nests observed in 2014 is difficult to explain, given the increase in adult stage butterflies recorded in 2015. A hypothesis predicated upon phenological disruption would raise questions about the appropriate timing for survey activities. This difficulty adds to the significant time spent by observers to conduct a comprehensive survey of breeding nests on the entire site. It is therefore likely that in the future this part of the study be set aside in favour of less constrained study of the adult stage.

The influence of environmental factors and the connectivity of Marsh Fritillary breeding sites is essential to conservation success. Fowles & Smith (2006) estimate that Marsh Fritillary metapopulations require a minimum of 100 ha of suitable habitat to achieve a 95% long-term probability of persistence. This translates as a necessary effort to maintain ecological corridors (connectivity) between sites, creating in this way, an operable system for metapopulation colonisation and spontaneous individual phenomena (Anthes *et al.*, 2003). With a landscape quality index of 87.11, we are far from the target index of 417.19 established by Fowles and Smith for viable habitat. It is therefore necessary to reconstitute a functional network of habitats.

In terms of species management, the maintenance of a functional corridor between the two populations, i.e. a grassy corridor between woodlands of at least 10 metres width receiving a minimum 2 hours of sunshine per day should be deemed prioritary. Natura 2000 and the programme supported by grants from the European Regional Development Fund (ERDF) have helped to conserve and restore parts of the chalky grasslands of the Boulonnais cuesta. New Natura 2000 institutional contracts have been negotiated with private owners of intermediary sites with a potential for connecting two population centres, with restoration and habitat conservation work to be implemented beginning in 2016. This management effort will require sustained effort over the coming years in order to establish sustainably functional corridors. Buffer zones to insulate favourable areas from highly unfavourable areas such as intensive farming should be envisaged.

It is therefore ***necessary to reconstitute a functional network of habitats***

At the level of the observation station, maintenance of Marsh Fritillary populations must necessarily address the preservation of a mosaic of habitats offering three essential types of habitats: richly flowering grasslands with nectars essential for the nurture of the adult Marsh Fritillary, transition areas rich in *Succisa pratensis* nesting areas (Smee *et al.*, 2010) and edge areas which provide shelter from the wind.

To achieve this optimum, several studies in England and

Belgium have shown that cattle grazing or partial mowing in alternating strips within species breeding areas are to be preferred to sheep grazing which is unfavourable to the host plant. The Devil's-Bit Scabious is a rather tall plant that competes well in dense vegetation areas. Close cropping by grazing sheep is detrimental to the low leaves of *Succisa pratensis*, which ultimately disappears. This finding, in general, is confirmed by our observations on the hills where sheep grazing (of the traditional Boulonnais race) was reintroduced.

On patches where grazing is not to be envisaged, management should organize partial mowing in alternative strips. Such a strategy is to be preferred in conserving habitat while only minimally impacting existing populations.

CONCLUSION

Started in 2013, following the rediscovery of the species, monitoring has provided a more precise idea of the Marsh Fritillary population of the Boulonnais cuesta. With a Pollard index of 502 in 2015, this population is currently the largest known population of this species in the Nord – Pas-de-Calais administrative region.

The species appears to be expanding since it was discovered at station 1. When nectar resources in the breeding habitat are exhausted, adults will forage into adjacent plots (usually grazed grasslands or abandoned strips of cultivated mustard, etc.).

If the species appears stable in the area, or even in an expansive phase, it remains fragile and tributary to habitat fragmentation. Sustained monitoring of the species will be essential over the coming years. Monitoring will improve knowledge of current populations as well as facilitate understanding of species dynamics.

The elements chosen for tracking must be of a nature to encourage managers of grassy habitats to take into account species preferences, grassland habitat and grasslands culture, including semi-annual and partial mowing of species nesting areas. The management and encouragement of actions leading to the establishment of ecological corridors between breeding stations should also be a priority. In addition, an environmental framework approach should be adopted with regard to the maintenance of chalky grasslands landscapes. The Boulonnais south cuesta shows strong signs of reforestation; it is necessary to restore spatial equilibrium amid the mosaic of habitats using appropriate management techniques, especially in view of encouraging a diversity of flora and fauna of the park's landscape.

If this study provides a clear vision of the evolution of current Marsh Fritillary populations of the Boulonnais cuesta, many questions remain unanswered.

From a perspective of population dynamics, are there any real exchanges between the two colonies? Why are the numbers for station 2 so weak? Is the colony in a phase of dynamic retention, expansion or regression? Is the species subject to parasites in the region? What factors are responsible for the disappearance of the species at historical stations? With respect to strengthening existing populations or reintroducing individuals on formerly occupied stations is there any real interest in the species for the region?

From a wildlife preservation point of view, what measures should be taken to maintain or restore at the same time the chalky grasslands and the habitats of the Marsh Fritillary? On what surfaces and around which stations should the park promote the Marsh Fritillary? What role do woodland boundaries play in favour of the species? What mowing conditions are most favourable to the species (frequency and removing or not of cuttings)? Would marked nests in anticipation of mowing activities produce a significant positive effect on population dynamics?


© M. Vilarelle

BIBLIOGRAPHY

ALDERWEIRELD, **F.**, **HUBERT**, **B.**, REY, G., 2014. *État des lieux de la répartition et évaluation de la qualité des habitats du Damier de la succise (*Euphydryas aurinia*) sur les sites historiques du Boulonnais (Pas-de-Calais).* Conservatoire d'espaces naturels du Nord – Pas-de-Calais. 48 p. **ANTHES, N., FARTMANN, T., HERMANN, G., KAULE, G**., 2003. *Combining larval habitat quality and metapopulation structure : the key for successful management of pre-alpine* Euphydryas aurinia *colonies*. – Journal of Insect Conservation **7 :** 175-185. **BOTHAM, M.S., ASH, D., ASPEY, N., BOURN, N.A.D., BULMAN, C.R., ROY, D.B., SWAIN, J., ZANNESE, A., PYWELL, R.F.**, 2010. The effects of habitat fragmentation on niche requirements of the marsh fritillary, Euphydryas aurinia, (Rottemburg, 1775) on calcareous grasslands in southern UK. *Journal of Insect Conservation* **15 :** 269–277. **BULMAN C.R., WILSON R.J., HOLT, A.R., BRAVO, L.G., EARLY, R.I., WARREN, M.S., THOMAS, C.D.**, 2007. Minimum viable population size, extinction debt, and the conservation of a declining species. – *Ecological Applications* **17(5):** 1460-1473. **DUPONT**, 200. *Programme national de restauration pour la conservation des lépidoptères diurnes* (Hesperiidae, Papilionidae, Pieridae, Lycaenidae et Nymphalidae). Première phase : 2001-2004. OPIE. 188p. **FOWLES, A.P., SMITH, R.G.**, 2006. Mapping the habitat quality of patch networks for the marsh fritillary *Euphydryas aurinia* (Rottemburg, 1775) (Lepidoptera, Nymphalidae) in Wales. *Journal of Insect Conservation* **10 :** 161–177. **GOFFART P., BAGUETTE M., DUFRENE M., MOUSSON L., NÈVE G., SAWCHIK J., WEISERBS A., LEBRUN P.**, 2001. - *Gestion des milieux semi-naturels et restauration de populations menacées de papillons de jours*. Division Générale des Ressources Naturelles et de l'Environnement. Division de la Nature et des Forêts. Région Wallonne. 123p. **HUBERT B. et HAUBREUX D. [coord.]**, 2014. *Liste rouge des espèces menacées du Nord – Pas-de-Calais - Papillons « de jour » (Lépidoptères Papilionoidea)*. Tableau synthétique. GON, CEN5962, CFR. 4p. **HUBERT B. ET JANCZAK A.**, 2014. *Plan régional de restauration pour la biodiversité. Papillons « de jour » (Lépidoptères Papilionoidae)*. Conservatoire d'espaces naturels du Nord et du Pas-de-Calais-Groupe ornithologique et naturaliste du Nord – Pas-de-Calais-région Nord – Pas-de-Calais, 153p. **LIU, W., WANG, Y., XU, R.**, 2006. Habitat utilization by ovipositing females and larvae of the Marsh fritillary (*Euphydryas aurinia*) in a mosaic of meadows and croplands. *Journal of Insect Conservation* **10 :** 351-360. **NOWICKI, P., SETTELE, J., HENRY, P.Y., WOYCIECHOWSKI, M.**, 2008. Butterfly monitoring methods : the ideal and the real world.-Israel Journal of Ecology and Evolution **54 :** 69-88. **POLLARD, E., YATES, T.J.**, 1993. *Monitoring Butterflies for Ecology and Conservation*.- Chapman and Hall, London. **POLLARD, E.** 1977. A method for assessing changes in the abundance of butterflies. *Biological Conservation*, **12** : 115–134. **POLLARD, E.** 1982. Monitoring butterfly abundance in relation to the management of a nature reserve. *Biological Conservation*, **24** : 317–328. **THOMAS J.A., & SIMCOX D.J.**, 1982. A Quick method for Estimating Larval Population *Melitaea cinxia* L. During surveys. Biological Conservation, **22** : 315-322. **VAN SWAAY, C.A.M., WARREN, M.S.**, 2006. Prime Butterfly Areas of Europe : an initial selection of priority sites for conservation. *Journal of Insect Conservation* **10:** 5–11. **VAN SWAAY, C.A.M., WARREN, M.S., LOIS, G.**, 2006. Biotope use and trends of European butterflies. J Insect Conserv **10 :** 189–209. **VILARELLE, M.**, 2013. *Étude du Damier de la succise (*Euphydrias aurinia*) dans le Boulonnais. État actuel des populations, évaluation des habitats et propositions de mesures de gestion conservatoire en faveur de l'espèce*. Parc naturel régional des Caps et Marais d'Opale 45 p. **VILARELLE, M.**, 2014. Suivi des populations de Damier de la Succise (*Euphydryas aurinia*) sur les pelouses calcicoles de la Cuesta du Boulonnais. Parc naturel régional des Caps et Marais d'Opale 25 p. **WILLIAMS, B.K., NICHOLS, J.D., CONROY, M.J.**, 2002. Analysis and management of animal populations. *Academic Press*, San Diego, California, USA. **ZIMMERMANN, K., BLAZKOVA, P., CIZEK, O., FRIC, Z., HULA, V., KEPKA, P., NOVOTNY, D.,SLAMOVA, I., KONVICKA, M., 2011**. Demography of adults of the Marsh fritillary butterfly, *Euphydryas aurinia* (Lepidoptera : Nymphalidae) in the Czech Republic : Patterns across sites andseasons. *Eur. J. Entomol.* **108 :** 243-254.

ANTS in the *Caps et Marais d'Opale* Regional Natural Park

A preliminary inventory for a new dimension for park naturalists


S. MÉZIÈRE[1]
P. WEGNEZ[2]

Abstract: Ants, hymenoptera of the family Formicidae are groups about which we know very little. Their geographic dispersion and possible commensal relations with other myrmecophilic species such as Lycaenidae (various species of gossamer-winged butterflies) suggest they play a key role in balancing ecosystems in various ecological programs, for example, in addressing hydrocarbon contamination on the Crau alluvian plain (in the Bouches-du-Rhône Department).

In order to improve knowledge of these little understood insects, several field inventories were conducted across the extent of the Parc naturel régional des Caps et Marais d'Opale. Some 21 species of ant were identified by a first census effort (5 days over 2 years) which concentrated on areas of remarkable interest in the RNR (Regional Nature Reserves) and calcareous grasslands. Fifteen species were identified, dominated by the genus *Myrmica*. Enriching the inventory database and harnessing ants' roles in seed keeping and for restoration of the natural habitat are critical considerations in designing ecological linkages.

Keywords: Ants, inventory, dispersion, knowledge, function.

***Résumé** : Les fourmis, hyménoptères de la famille des Formicidae, sont des groupes peu connus. Leur capacité de dispersion et de transport (myrmémochorie), la zoochorie active et leur relation symbiotique avec certains insectes myrmécophiles (ex.. : les lycènes) témoignent de leur rôle essentiel dans l'équilibre des écosystèmes parfois mis à profit dans des programmes de génie écologique (ex. : pollution aux hydrocarbures de la plaine de la Crau).*

Afin d'améliorer la connaissance de ces insectes encore méconnus, des sessions d'inventaires se sont déroulées au sein du Parc naturel régional des Caps et Marais d'Opale. À ce jour, 21 espèces ont été recensées par une prospection initiale (5 jours en 2 ans) qui a été centrée sur des milieux remarquables comme les Réserves naturelles régionales (RNR) et des coteaux calcaires (15 espèces dominées par le genre Myrmica). Étendre les inventaires et mieux valoriser leur rôle de pépiniériste, tant pour la restauration des milieux naturels que pour les trames écologiques, sont de vrais défis d'avenir.

***Mots-clés** : Fourmis, inventaire, dissémination, connaissance, fonctionnalité.*

1. The Caps et Marais d'Opale Regional National Park (PNRCMO) – BP 22 – 62142 Colembert – smeziere@parc-opale.fr
2. Co-author of *Fourmis de France, Belgique et du Luxembourg*, President of the naturalist association Fourmis WalBru dedicated to the knowledge of ants in Wallonia.

The Yellow meadow ant, *Lasius flavus.* © P. Wegnez

INTRODUCTION

Ants, although small and familiar, present a diversity which is little known and virtually undocumented in the Nord – Pas-de-Calais region, and this without mentioning the vital niche occupied by ants in our local ecosystems. As part of a national effort by the association ANTAREA to establish a cartography of ant species present in France, and, in accordance with the Park's charter mandate for the improvement of naturalist knowledge, the Caps et Marais d'Opale Natural Park accepted the challenge of this unique study theme.

We first turn our attention to the fundamental contribution of ants to the functioning of ecosystems, which, by virtue of their role in the dissemination of seeds, consecrates ants as the species par excellence in service to ecological continuity.

Secondly, a close association with the Walloon association "Fourmis WalBru" and its president, Philippe Wegnez, author of numerous publications on the subject of ants, allowed the Park and Association to pursue a two-year collaboration resulting in the establishment of bases for a species inventory and knowledge on this family of insects.

ANTS AND ECOLOGICAL FUNCTIONALITY: THE NURSERYMEN OF TOMORROW?

Just like wasps, bees and bumblebees, ants are of the order Hymenoptera, stemming from "hymen", Greek for "membrane" and "pteron" for wing, and referring to the four membranous wings of this insect order. By the hundreds, winged males and queens from a source colony fly into the air to mate, leaving wingless worker ants in the colony to continue the process of feeding the ant larvae. The phenomenon known as swarming then leads to the founding of a new ant colony. In passing, we note that ants are "eusocial" and organized into three principal castes: males, queens and workers (and sometimes soldiers).

Unlike hymenoptera of the infra-order Terebrantes, a related group of parasitic species possessing auger-shaped ovipositors, ants have stingers (which are often atrophied), which places them among the infra-order Aculeata (from Latin, *acutus* or sharp). Ants are assigned to a proper family, the Formicidae which is itself sub-divided into numerous sub-families: Myrmicinae, Ponerinae, Dolichoderinae, Formicinae…

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Sub-class	Pterygota
Infra-class	Neoptera
Super-order	Endopterygota
Order	Hymenoptera
Sub-order	Apocrita
Infra-order	Aculeata
Family	Formicidae

Whilst taking inventories between 2014 and 2015 most of these subfamilies were identified. This preliminary inventory of ants is a direct emanation of the Regional National Park Charter for a "territory which takes to heart the issue of biodiversity".

The blue-green network is the basis for French SRCE (*Schéma Régional de Cohérence Écologique*, or Regional Plan for Ecological Coherence). The purpose of the SRCE is to ensure that biodiversity tanks are connected to one another by ecological corridors. At least, that is the theory.

In practice however, the SRCE framework faces a multitude of fragmenting elements that undermine ecosystem functionality. It is estimated that the Nord – Pas-de-Calais biotope region is fragmented into 85,000 pieces. Landscape and ecological fragmentation represent so many physical barriers separating one habitat from another, disrupting intra-community innovation, social behaviours and phenological adaptations, and compromising community viability. As individuals disappear and barriers disrupt species adaptation, communities lose their resiliency and find they can no longer align themselves with changing environmental demands. Isolation also engenders inbreeding and genetic susceptibilities that may prove fatal over the long term. Fragmentation of natural habitats is recognized as a leading cause of species extinction.

Lasius emarginatus. © P. Wegnez

While frameworks are emerging on a large scale, it is in an infinitely smaller world that ants ceaselessly work to connect ecosystems.

THE ROLE OF ANTS IN AN ECOSYSTEM

MOVING THE IMMOBILE: MYRMECOCHORY

For plants, a possible solution to the difficult problem of habitat fragmentation may be the facilitation of seed dispersal. Without a means of dispersal, external assistance is required. Even if a habitat appears homogeneous, without a "vector" seeds would not disseminate. Like dispersal by the wind (anemochory), by water (hydrochory) animals also play a role in seed dispersal. On the limestone slopes, the sheep, cattle and other foraging mammals transport seeds that cling to their fur. Thus one may follow certain dispersions in the footsteps of roaming herds. Such vectors of dispersion are called zoochory and are of essentially two types: epizoochory and endozoochory. On the same principle, we must imagine myrmecochory or seed dispersal accomplished by tiny ants on infinitely smaller routes.

*The ants are involved in **seed dispersal***

Who has not at least once in his or her life seen columns of ants coming and going in the garden, all looking very busy? If we look more closely, many of the ants in the column are transporting seeds destined for consumption in the colony. It is by occasionally losing a part of this "cargo" that the "column" accomplishes a first form of seed dispersal, a dyszoochory most common among squirrels and jays.

A second form of dispersion, called active zoochory refers to the morphology of the seeds. Some seeds have an excrescence which is palatable for ants and whose consumption does not affect seed germination, the so called elaiosome (from Greek: "elaios", oil + "some", body). Removing the elaiosome from the seed is too much for a single worker and not particularly efficient in view of the final object, feeding the young. The seed then is transported to the ant nest where the elaiosome is consumed, and the spent seed deposited in the communal "discharge", an ant compost

PHOTO BOARD

1) *Lasius mixtus*; 2) *Lasius fuliginosus*; 3) *Myrmica rubra*; 4) *Monomorium pharaonis*; 5) *Formica cunicularia*; 6) *Lasius brunneus* 7) *Myrmecina graminicola* 8) *Lasius emarginatus*. © P. Wegnez

heap of sorts, where the seed will eventually germinate. Based on this mutually beneficial relationship, we speak of symbiosis.

Some plant species such as violets, snowdrops, anemones take full advantage of this interaction. Other species, even heritage and threatened species, take advantage of "ant hills". Yellow meadow (*Lasius flavus*) anthills are generally built along the edges of chalky fields, overlooking the dominant *Brachypodium pinnatum*. These mounds provide shelter for certain species (genera *Thymus, Festuca, Linum*, etc.) that would not otherwise have withstood competition of the more competitive plants.

Be careful when considering the "dispersive" role of ants. While they do indeed provide an important ecological service over short distances, something on the order of ten meters, it may take several decades before ant colonies extend to multiple linear spaces.

WORKER ANTS FOR ENVIRONMENTAL RE-COLONISATION: THE EXAMPLE OF THE CRAU

The Nord – Pas-de-Calais is one of the most artificialized and least diverse regions of France with a long history of intensive agriculture and altered ecosystems. In the Nord – Pas-de-Calais, soils are productive only when coaxed by chemicals increasingly recognized as dangerous. Is the poor health of our natural spaces reversible? Will we have to use ants in the future to help the resilience of our natural systems? Can ants help us reconnect our fragmented natural spaces? These are only a few of the many questions addressed by progress in environmental engineering.

Ponera coarctata worker ants. © P. Wegnez

Lasius fuliginosus. © P. Wegnez

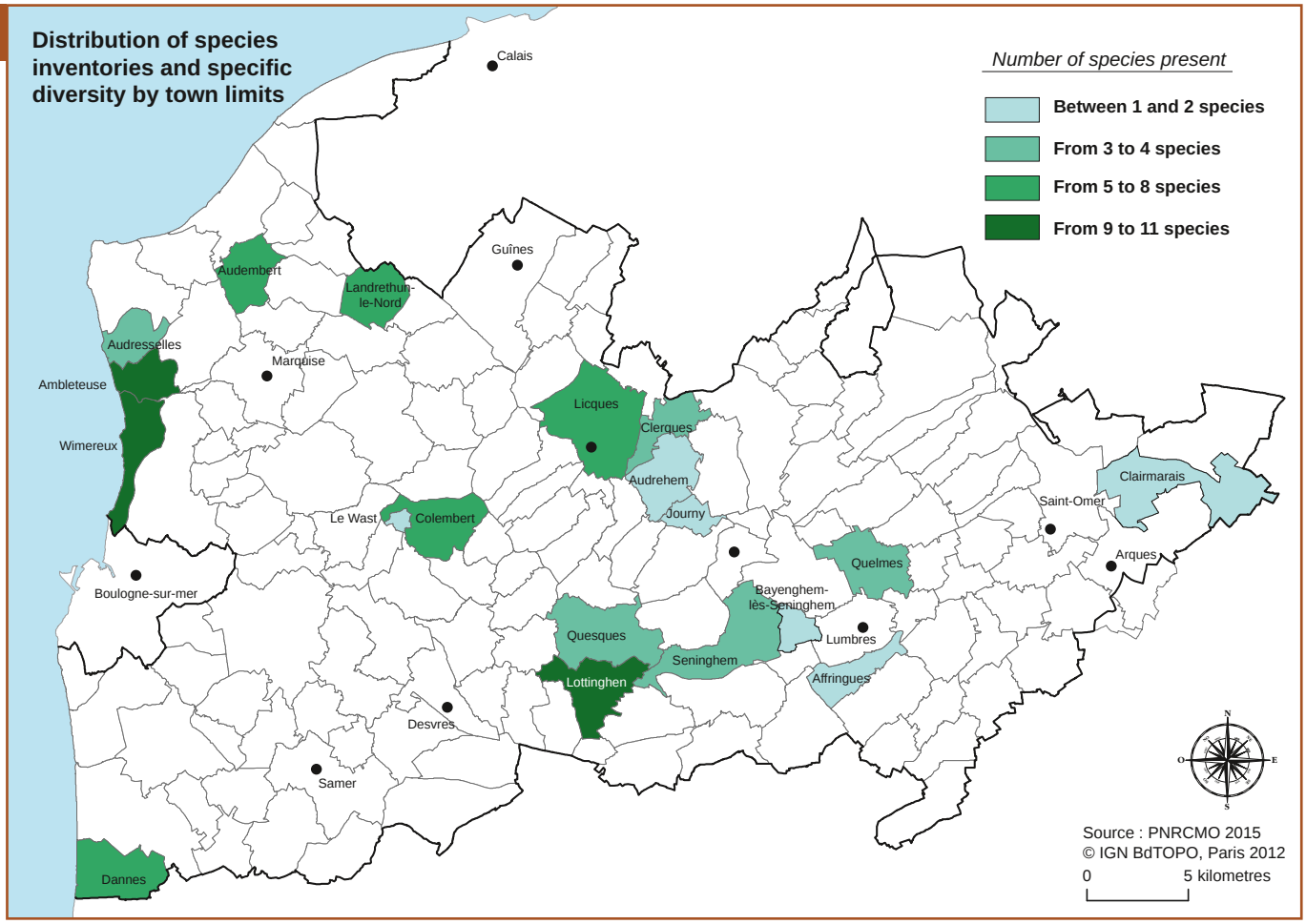
The example of the successful introduction of harvester ants (genus *Messor*) in the plain of the Crau raises as many questions as it does hopes for the future.

The Crau, former delta of the Durance River and unique example of a semi-arid steppe in Western Europe is a nature reserve and refuge for a number of species endemic to the Rhône Delta. The Crau Nature Reserve in 2009 experienced an oil spill which resulted in the release of over 4.5 million litres of crude oil into a sensitive environment and shallow water table. Where nature might have taken thousands of years to reintroduce local grasses and plant species (an insect colony has a one-in-a-thousand chance of success) with human assistance the chances of success were improved to one in two, or 50%[1].

Indeed, fertilized queens of these seed-eating ants were introduced with a view to founding new colonies counting between 8,000 and 25,000 individuals. Every year, the mass of seeds forgotten by one of these colonies is numbered in

1) http://www.lesechos.fr/21/05/2012/LesEchos/21188-037-ECH_la-depollution-naturelle--nouveau-defi-pour-le-cnrs.htm

Map



kilograms, with a significant number and variety of plant species available to reconstitute the flora of this exceptional environment.

ECOLOGY, MATERIALS AND METHOD OF STUDY

Some butterflies (e.g. the Common Blue, *Polymmatus icarus*) are well known for the symbiotic nature of their relations with ants of the genus *Myrmica*. This relationship is expressed through consumption by ants of the sugary substance (honeydew) produced by the caterpillars of several species. Among the most emblematic of these, the caterpillars of the *Maculinea* butterfly benefit from a national action plan in view of the threats these species confront.

Almost all caterpillars of the Gossamer-winged butterfly (family Lycaenidae) are myrmecophilous. Among French Polyommatinae, Lafranchis and Kan[2] report that only three species appear to bear no relation to the ants: the Arctic Blue (*Agriades glandon*), the Gavarnie Blue (*Agrieades pyrenaicus*) and the Cranberry Blue (*Plebejus optilete*).

If the fauna of the Nord – Pas-de-Calais region does not include species of *Maculinea*, it does nevertheless count a number of Lycaenidae, including the Silver Studded Blue (*Plebejus argus*) a species that is openly myrmecophilous, and whose reproductive presence has been documented for some sites in the Pas-de-Calais. The literature seems to attribute to this butterfly a special relationship with ants of the genus *Lasius*.

That is why, in 2014, in collaboration with the Conservatoire des Espaces Naturels and Philippe Wegnez, a collective effort was made to inventory ant populations amid the limestone slopes and dunes of the *Côteau de Dannes-Camiers* Regional Nature Reserve administered by the Conservatoire. The purpose of the inventory was to learn more about the species present on the site. On this occasion, 8 ant species were encountered including two species of *Lasius* (*Lasius brunneus* and *L. flavus*). The large number of anthills of the latter species on the site is noteworthy.

This first glimpse served as an incitement to pursue these

Special relations between a butterfly and ants

2) Lafranchis, Kan, *Relations entre fourmis et plusieurs lycènes de France*, Oreina n°19 2012

A column of *Messor* sp. ants carrying an *orthoptera*. © P. Wegnez

inventories on other sites known to host *Plebejus argus*. At the very least, this would allow researchers to correlate the presence of this ant species with efforts to conserve the butterfly.

It is as a result of this ground-breaking work that we are able to describe first results of ant inventories carried out on the territory of the Regional Natural Park.

The results presented below are based on:

- A review of the scientific literature;
- Research conducted by the association ANTAREA, and
- Specific surveys carried out in collaboration.

Working closely with the National Museum of Natural History and as part of the French natural heritage inventory (INPN), the association ANTAREA offers a participatory system where any interested person can submit ant specimens for identification by experienced myrmecologists. This validation is important because, scientific credit is predicated upon this updated information.

Finally, this project is part of a larger project to establish a cartography and distribution of ants in France, and by extension, to refine the systematics of this family. By cross-regional contributors, this project will significantly enrich the knowledge of ants in the Nord – Pas-de-Calais Region as well as the territory of the Regional Natural Park Caps et Marais d'Opale.

RESULTS AND DISCUSSION: MYRMECOLOGICAL INVENTORY AND SPECIES UNDERSTANDING IN THE CAPS ET MARAIS D'OPALE REGIONAL NATURAL PARK

During the 2014-2015 inventory sessions, 21 species were recorded; 13 species listed in the Cavro catalogue were found but 20 other were not.

SPECIES CITED IN CAVRO NOT FOUND IN 2014-2015	
SUB-FAMILY	**Species**
PONERINAE	*Ponera coarctata*
MYRMICINAE	*Myrmica laevinodis = Myrmica rubra*
MYRMICINAE	*Myrmica lobicornis*
MYRMICINAE	*Stenamma westwoodii*
MYRMICINAE	*Monomorium pharaonis*
MYRMICINAE	*Solenopsis fugax*
MYRMICINAE	*Formicoxenus nitidulus*
DOLICHODERINAE	*Tapinoma erraticum*
FORMICINAE	*Plagiolepis pygmaea*
FORMICINAE	*Camponotus ligniperdus/ligniperda*
FORMICINAE	*Formica rufa*
FORMICINAE	*Formica pratensis*
FORMICINAE	*Formica truncicola/truncorum*
FORMICINAE	*Formica sanguinea*
FORMICINAE	*Formica cinerea*
FORMICINAE	*Dendrolasius fuliginosus/Lasius fuliginosus*
FORMICINAE	*Lasius mixtus*
FORMICINAE	*Lasius alienus*
FORMICINAE	*Lasius umbratus*
FORMICINAE	*Prenolepsis vividula*

A nest of *Formica cunicularia.* © P. Wegnez

A nest of *Myrmica rubra* (queen and workers). © P. Wegnez

A nest of *Myrmecina graminicola.* © P. Wegnez

A nest of *Lasius flavus.* © P. Wegnez

SPECIES IDENTIFIED DURING PARK INVENTORIES IN 2014-2015	
SUB-FAMILY	**Species**
PONERINAE	*Ponera coarctata*
MYRMICINAE	*Myrmica rubra*
MYRMICINAE	*Myrmica ruginodis*
MYRMICINAE	*Myrmica scabrinodis*
MYRMICINAE	*Myrmica rugulosa*
MYRMICINAE	*Myrmecina graminicola*
MYRMICINAE	*Tetramorium caespitum*
FORMICINAE	*Formica fusca*
FORMICINAE	*Formica rufibarbis*
FORMICINAE	*Lasius flavus*
FORMICINAE	*Lasius niger*
FORMICINAE	*Lasius brunneus*
FORMICINAE	*Lasius emarginatus*

SPECIES DESCRIBED BY CAVRO AND FOUND DURING 2014-2015 PARK INVENTORIES	
SUB-FAMILY	**Species**
PONERINAE	*Ponera coarctata*
MYRMICINAE	*Leptothorax acervorum*
MYRMICINAE	*Myrmica rubra*
MYRMICINAE	*Myrmica ruginodis*
MYRMICINAE	*Myrmica scabrinodis*
MYRMICINAE	*Myrmica rugulosa*
MYRMICINAE	*Myrmica sabuleti*
MYRMICINAE	*Myrmica specioides*
MYRMICINAE	*Stenamma debile*
MYRMICINAE	*Myrmecina graminicola*
MYRMICINAE	*Tetramorium caespitum*
FORMICINAE	*Formica cunicularia*
FORMICINAE	*Formica fusca*
FORMICINAE	*Formica rufibarbis*
FORMICINAE	*Lasius flavus*
FORMICINAE	*Lasius niger*
FORMICINAE	*Lasius brunneus*
FORMICINAE	*Lasius fuliginosus*
FORMICINAE	*Lasius emarginatus*
FORMICINAE	*Lasius psammophilus*
FORMICINAE	*Lasius platythorax*

Tetramorium sp workers. © P. Wegnez

More generally, there is little historic data on the diversity of ants in the Nord – Pas-de-Calais region. If the Natural History Museum of Lille has several collections that might be consulted, it is likely that entomologists here and there have further samples in private collections not generally accessible at the time of this writing.

Of course, we must also mention the work of Cavro who in 1950 published a catalogue of the Hymenoptera of the Nord Department and neighbouring regions. The catalogue reports 33 (32)[3] ant species including 1 species of Ponerinae, 13 (12) Myrmicinae, 1 Dolichoderinae and 18 Formicinae. Among them, we note the presence of two exotic species: *Monomorium pharaonis* and *Prenolepis vividula.*

For comparison, Europe has just over 400 species (as opposed to 14,095 described species for the World). France, according to the ANTEREA census, counts 203 species, Belgium accounts for 87 species. Inventories conducted in 2014 and 2015 on the territory of the Caps et Marais d'Opale RNP, cross referenced to Cavro provide a first glimpse of the potential for the Nord – Pas-de-Calais region.

In view of the neighbouring regions, this encouraging first report suggests opportunities for further study, offering a guide for future research.

DISTRIBUTION OF ANTS WITHIN PARK LIMITS: A FIRST DRAFT MAP

Since 2014, 19 of 154 Park municipalities report the presence of at least one species of ants (excluding data for ANTAREA) accounting for 5 days of prospecting over 2 years. This is representative of an exploration effort for which emphasis was placed on the most outstanding coastal environments (the nature reserve Mont du Couple, the communal fields of Ambleteuse, the nature reserve Côteau de Dannes-Camier) following which, in a second round, among the dryer landscapes, principally because of the affinity of certain thermophilic species these sun-drenched slopes. As such, the chalky hills of Clerques, Quelmes, Affringues, Seninghem, Licques and Audrehem were the object of special attention.

It should be noted that in 2015, special attention was also given to stone walls, landscaping elements with potential consequences for blue-green infrastructure and ecological corridors and characteristic of the Boulonnais. With only five species identified, the results were not convincing.

THE SPECIES COMMONLY ENCOUNTERED

During these surveys, three species were almost always found. Among the 19 municipalities inventoried, *Lasius flavus* was encountered on 14 occasions, *Lasius niger* on 13 occasions and *Formica cunicularia* was identified 11 times. *Lasius niger* and *Lasius flavus* proved somewhat ubiquitous and just as likely to be spotted in urban as in rural areas, even though *Lasius flavus* seemed more easily detectable in grassy open areas, especially through the sometimes well visible ant hills. It was also common to find *Lasius flavus* colonies at the base of fences in grazed areas, places sheltered from animal excretions. The vegetation in these areas is generally similar if not the same as the original area vegetation with little or no amendment, in this condition, the vegetation dispersion is fostered by ants. (In this habitat species of the genus *Thymus* may be found). A study of the vegetation found among yellow ant hills would, as such, be extremely interesting.

INFREQUENT SIGHTINGS

Five species of ants were found only once in inventories: *Ponera coarctata, Myrmica rugulosa, Lasius mixtus, Lasius brunneus, Lasius platythorax.*

In terms of the occurring species, most of which are widely represented in Wallonia, it is too early to speak of rarity.

We emphasize, however, the presence of *Ponera coarctata*, more difficult to detect because of the species' very small size or *Lasius mixtus* a priori limited to chalky grasslands and a parasite on other ants' nests, in particular *L. flavus*, *L. niger*, etc.

3) Cavro dresse un bilan de 33 espèces, cependant après plusieurs relectures attentives de son article, nous n'en comptons que 32.

ANTS OF THE CHALKY SLOPES

Like most insects, ants demonstrate a marked preference for hot and dry environments. As such, the calcareous landscapes of the Natural Park offer a hospital environment for such species and special attention was paid to the diversity of ants on the chalky soils of the Caps & Marais d'Opale Regional Natural Park. This inventory of the hillside ants was done in order to, by improving the faunal knowledge of this habitat, gather new elements allowing to characterize its originality along with integrating an additional dimension in the understanding of the ecological functions that govern this type of environment.

In all, 15 of the 21 species inventoried were found among the chalky slopes. We almost systematically encountered *Formica cunicularia* and assume that, for those few hills where this species was not found, complementary inventory will reveal the presence of this heat loving species.
Moreover, it was remarkable to note the diversity of the *Myrmica* species (*M. rubra, M. ruginodis, M. sabuleti, M. scabrinodis*) amid these calcareous sites. While most species are able to occupy a wide range of natural environments, *Myrmica sabuleti,* probably the most thermophilic species of the 4, was the most widely represented being present in 47% of the inventoried sites.

CONCLUSION AND PERSPECTIVES

This preliminary inventory of ants in the Caps et Marais d'Opale natural park prefigures, we hope, a broader effort on a regional scale. In this way it will be necessary to continue this primary mission of acquiring environmental knowledge on areas underdocumented representative of the landscape mosaic of the Park, including marshes, forests and farmlands. The fields of investigation surrounding this family of insects are manifold: whether considering simple improvements in the knowledge of species distribution or further research on species usefulness in the context of the restoration of natural environments and ecological frames, we can imagine that extremely interesting prospects for study in the coming years are opening. At present we are merely taking our first steps toward organizing this knowledge base. This early work should at the very least, arouse curiosity and encourage new contributors to support the ANTAREA project. Finally, we should remember how ants by their very nature are the first true nurserymen of nature. If they disseminate and sow or otherwise naturally disperse seeds into habitats of high patrimonial value these little animals, so poorly known today may be our best allies for the reconquest of tomorrow.

ACKNOWLEDGMENTS

We are especially grateful to Philippe Wegnez, co-author of the book, *Fourmis de France*, for his critical reading of our manuscript and for sharing his years of experience in identifying the hymenoptera fauna of the Nord – Pas-de-Calais region. We are also grateful to all who, curious about these " lil'bugs " contributed their time and good humour to finding and cataloguing our local ant species, including Bruno Derolez, Théalie Dhellemmes, Marie-Laure Challamel, Alexander Marcy, Anaelle Gourlet, Charlotte Bouin, Gwendoline Richault.

BIBLIOGRAPHY

BLATRIX R., GALKOWSKI C., LEBAS C., WEGNEZ. P., *Fourmis de France*, Delachaux Niestlé, 2013. **WEGNEZ P., IGNACE D.**, Fourmis de Wallonie (2003-2011), Serie « Faune-Flore-Habitat N°8 », publication du département de l'étude du milieu naturel et agricole, 2012. **DE BISEAU J.C., COUVREUR J.M.**, *Fourmis (Formicidae), Faune de Belgique*, Institut Royal des sciences naturelles de Belgique, 1994. **DELLA SANTA E.**, Guide pour l'identification des principales espèces de fourmis de Suisse, Centre Suisse de cartographie de la faune, 1994. **SKINNER G.J., ALLEN G.W.**, Ants, 2013. **B. LE GARFF**, *Dictionnaire étymologique de zoologie*, Delachaux et Niestlé, 1998. Région Nord – Pas-de-Calais, *La stratégie régionale pour la biodiversité*. **ALIGNANT, DEBRAS, DUTOIT**, En plaine de Crau, les insectes baromètres de la restauration écologique, *INSECTES* 25 n°168 - 2013 (1).

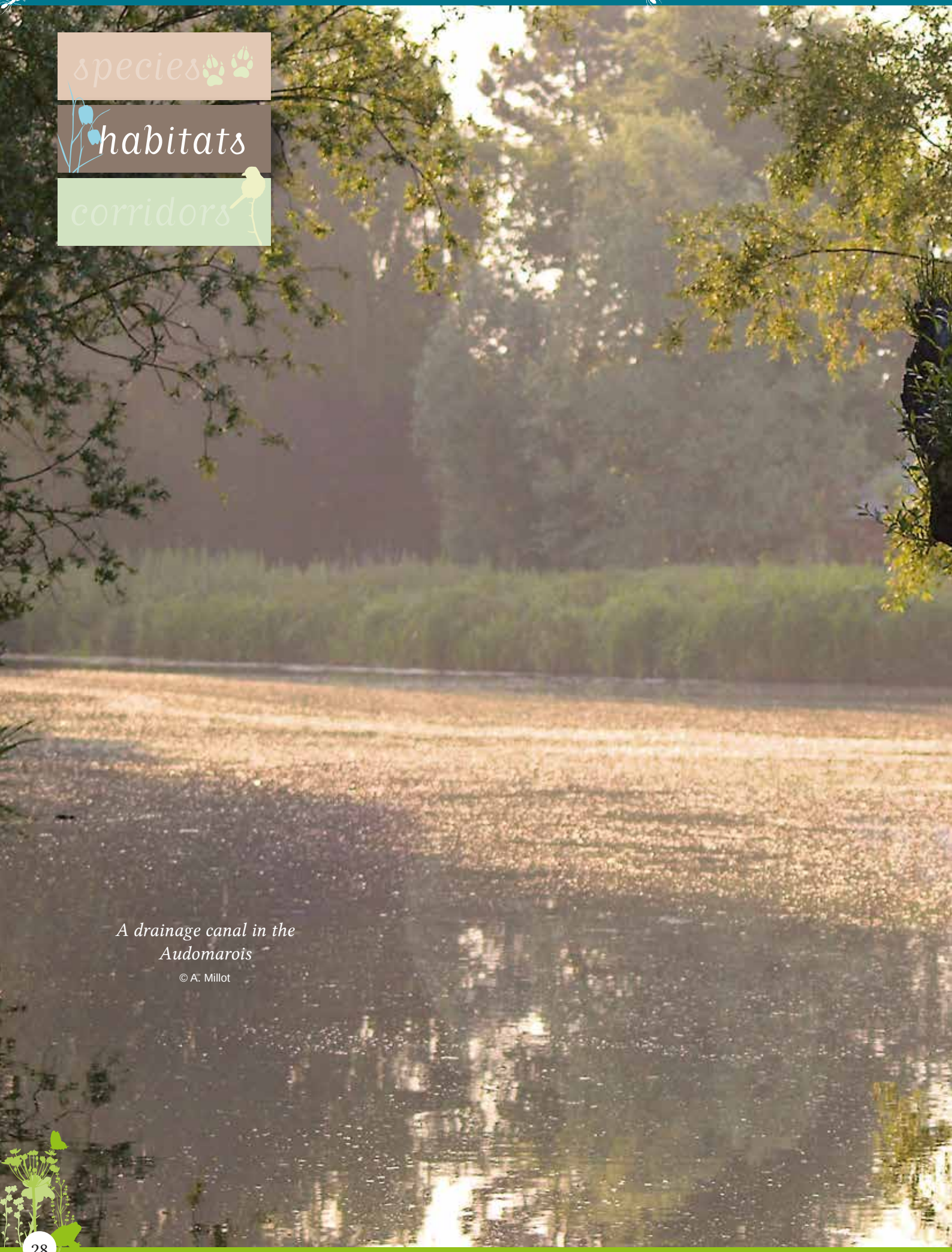
INTERNET SITES

http://myrmecochorie.free.fr • www.antarea.fr

species

habitats

corridors



A drainage canal in the Audomarois

© A. Millot

THE FUNGI OF CALCAREOUS SOILS

D. HUART[1]

Abstract: The author studies the historical fungi of chalky hills across the extent of the *Parc naturel des* Caps et Marais d'Opale (the slopes of the Boulonnais, the woods and secondary chalk downs of the Licques countryside). The article points to the value of fungi as bioindicators in evaluating the quality of a site and management strategies.

Keywords: Fungi, chalky hills and downs, historical landscapes, bioindicators, Boulonnais, Weald-Artois Anticline, the Licques territory.

Résumé: *L'auteur étudie la fonge patrimoniale des coteaux calcicoles du territoire du Parc naturel des Caps et Marais d'Opale (cuestas du Boulonnais et du Pays de Licques et secondairement versants de vallées crayeuses). Il souligne l'intérêt de la fonge comme bioindicateur dans l'évaluation de la qualité d'un site et de ses modalités de gestion.*

Mots-clés: *Fonge, coteau calcicole, espèce patrimoniale, bioindicateur, Boulonnais et pays de Licques.*

INTRODUCTION

The fungi of the chalky hill habitat of the Nord – Pas-de-Calais region are interesting in more ways than one. First, they are specific to these sun-loving environments. The British speak of "waxcaps" and of "waxcap grasslands". When fungi season ends in the woodlands and forests, the waxcaps become abundant, offering, as early as October if it has rained and until mid-December if it has not been too cold, mushroom species that are often very colourful, dressed in red livery, in yellow, and even in multiple colours like the aptly named Parrot waxcap.

For mycologists, the fungi on park territory were virtually unknown and there was no historical data. Over the past decade, the region's unique chalky landscapes have come under public management (the Regional Natural Park, the Conservatory of natural spaces or CEN, and EDEN62), greatly improving public access and the availability of these spaces for study. In some cases these hills had continued to serve as pasturelands for cattle grazing, in others cases, the lands had been cleared and recycled as pasturelands, especially sheep pasture, and so made the sporophores more visible. This facilitated the discovery of species new for the Nord – Pas-de-Calais region, such as the Pink Waxcap (*Hygrocybe calyptriformis,* photo **plate I** and *H. nitrata*), discovered in 2014 and testament to the richness of these sites. The purpose of this article is to demonstrate the relevance of fungi as bioindicators commensurate with the flora. Indeed, fungi appear to be even more susceptible than vascular plants to environmental disturbances, whether through intentional soil amendments and overgrazing, or by abandonment and trivialisation of the fungi populations.

MAPPING AS AN EVALUATION TOOL

In the field, six years of monitoring have been logged since 2009, ranging from September and especially October, through early to mid-December, for a variable period depending on the site and the relative abundance of fungi. A total of twenty sites were visited although unevenly. The site Le Breuil (Samer) received only a one-hour tour

1. Member of the SMNF (Société Mycologique du Nord de la France) – 8, avenue de Champagne – F-62360 Condette – didier.huart@sfr.fr

PHOTO PLATE I

1) *Entoloma madidum* (2) ; 2) *Entoloma incanum* (3) ; 3) *Hygrocybe calyptriformis* (1) ; 4) *Hygrocybe punicea* (2) ; 5) *Hygrocybe aurantiosplendens* (2) ; 6) *Microglossum olivaceum* (2). © D. Huart

( ) : As listed in the September 2000 edition of the IUCN Red List.

in six years, Audrehem, Clerques and Quelmes, beginning in 2011, each were visited between 40 and 60 hours. The route followed was adapted over the years to take into account the potential identified over previous visits, leaving areas poor in mushrooms for occasional visits. The large number of sites, often quite large (several tens of hectares) and widely scattered, imposed its choices, especially since physical access was often difficult on slopes varying from 10 to 45°. The presence of *Brachypodium* species and other grasses frequently masked the often small (genus *Entoloma*) and/or lightly coloured mushrooms barely apparent in the surrounding vegetation.

The objective of the visits was as much to get an idea of the presence of fungi on an individual landscape as much as on all landscapes and in this way to describe "**a fungal landscape**" at a given time. The genera and species each having their own phenology, the hygrocybes succeed the more precocious entolomæ.

Geolocalised observations were collected beginning in 2012 at a rate of 20 to 40 species per hour, including the number of spore bearing bodies within a given radius, with critical species reviewed more closely under a microscope upon return. We recorded only those registered as species with high natural heritage value from the "CHEG group", defined by British mycologists and referring to grassland and field and classified as genera C for *Clavariacae*, H for *Hygrocybe*, E for *Entoloma* and G to *Geoglossacae* eventually including the *Dermoloma* and possibly *Camarophyllopsis*. For species selection we relied upon the 2000 regional Red List. If an abundance of a particular red-listed species was discovered (e.g., *Clavulinopsis corniculata* **photo plate II** in Quelmes on 28 Nov. 2014, or *Hygrocybe konradii* found in Camiers in 2009) this was noted in the commentary specifying the species and observed abundance. On an auspicious day or year, a particularly rich site of one metre square might show five or six Red List species requiring a cartographic choice.

It is hard to imagine the diversity of mushroom colours

Mapping reveals broad diversity of fungi across a site

A hill site should not be measured only in terms of the number of species present. A classical site inventory, if it provides an idea of richness of a site, hardly shows the extent of diversity or site dynamics.

In approaching the issue of cartography, it seemed appropriate to limit our search to species listed with high natural heritage value, and so to avoid map clutter. Our map would thus note the abundance for each station according to certain thresholds (1-2; 3-7; 8-12, >12 on a fixed radius). In this way the mapping allows a better comparison among sites, the hundred or so *Hygrocybe punicea* **photo plates I and II** found in Audrehem not being comparable to the single sighting one year in Audembert (on the Mont de Couple site), such sightings often appearing as islands in a mycological wilderness (Mont de Couple or Clerques sites, among others such as Nabringhen).

This fungal heterogeneity raises a series of questions. Among these apparently uniform, calcareous landscapes, to what extent are edaphic variations (soil pH, water balance) in slope habitat or exposure explanatory factors? Should we look elsewhere for explanations, perhaps to the various uses these fields have been put going back a few decades, or are they part of recent or current management?

The aerial view and map on page 34, show examples of a field inventory in Audrehem and possibly provides some answers. Nearly 140 observations were obtained over 5 hours exploring this field. The legend identifies 29 of the observed species (about 40 in all). Other more mundane species were noted but not localized. They nevertheless fall within the overall assessment of the site (*Hygrocybe psittacina* for example, *Cuphophyllus virgineus*, *Hygrocybe conica*, *Entoloma hebes*, *Entoloma sericeum*, *Entoloma conferendum*). For each genus, a symbol was chosen (round for *Entoloma*, a star for *Geoglossacae*, a triangle for the *Hygrocybe*, and so forth). Colours were assigned to resemble as closely as possible the mushrooms themselves, set on the bottom and around the edges. The number of observations for each species is not provided on this map although other maps were produced for rare species (for example, *Entoloma bloxamii*, **photo plate I**, or the *Hygrocybe punicea* on **photo plates I and II**) which do account for abundance. In the medium term, the mapping should also allow researchers to track fungus dynamics. The mycological season is short, with some *Entoloma* appearing for only one week. The year-on-year variability being as much as from 1 to 100, the question becomes whether from one year to the next it has extended its range, increased its density or both the management measures being the same.

PHOTO PLATE II

1) A troop of *Hygrocybe punicea* in Quelmes ; 2) *Clavulinopsis corniculata* ; 3) *Cuphophyllus colemannianus* ; 4) Coteau d'Audrehem (2) ; 5) *Entoloma of the* roseum *species group* (2) ; 6) *Hygrocybes aurantiosplendens ;* 7) *Hygrocybes coccinea.* © D. Huart

RESULTS

Hillsides of regional even national interest for the most prolific among them

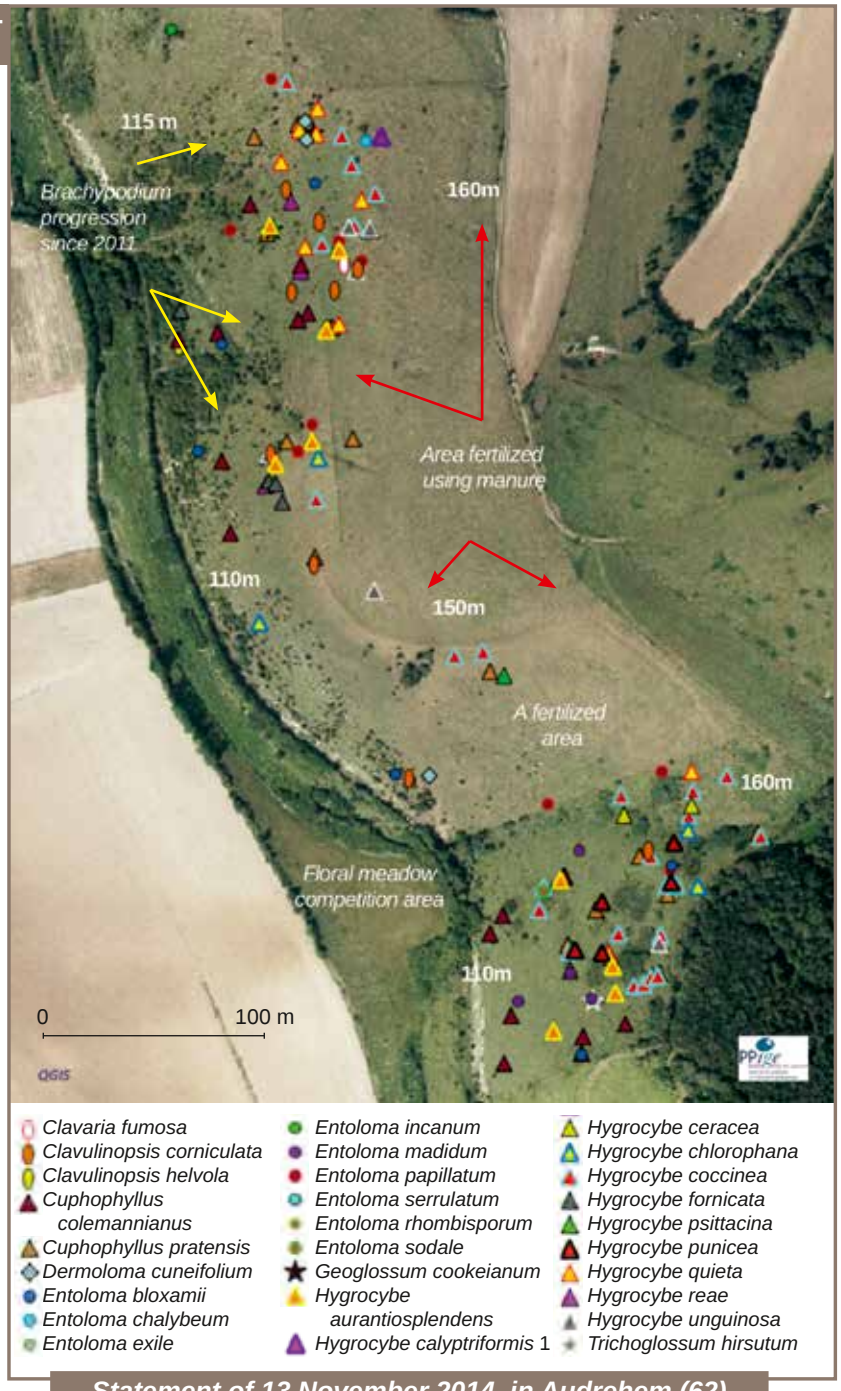
The table below shows the British site assessment protocol based on the CHEG model and the number of species in the complex. Other rankings assign ratings based on the rarity of the species and their classifications as species. We based our ranking on a protocol based on the number of species collected over multiple visits, not a single visit, counting only Rotheroe (1999) "waxcaps" (*Hygrocybe* + *Cuphophyllus*). The author provides the following ranges:

- *Hygrocybes*
- [17-32] = A site of national significance
- [9-16] = A site if regional significance
- [4-8] = A site of local interest
- [1-3] = no interest.

The following classification is thus obtained for November 2014 based on the chalky hills visited within the Park.

Municipality (site)	Managing entity	Number of *Hygrocybe* and *Cuphophyllus*
Audrehem	PNR	24
Quelmes	PNR	21
Clerques	PNR	19
Audembert (mont de Couple)	PNR	14
Nesles (Motte Castrale)	PNR	10
Escalles (Blanc Nez)	PNR	8
Camiers	EDEN 62	8
Dannes	CEN	8
Longueville (Saint-Sylvestre)	CEN	8
Quesques	PNR	7
Desvres (Mont Pelé)	EDEN 62	7
Wavrans	CEN	7
Acquin	CEN	6
Affringues	PNR	6
Bonningues	PNR	6
Seninghen	PNR	4
Escalles (mont d'Hubert)	EDEN 62	3
Samer (Le Breuil)	PNR	3
Nabringhen	PNR	3

Map



Statement of 13 November 2014, in Audrehem (62)

Three sites, Audrehem, first among them, but also Quelmes and Clerques, deserve to be ranked as sites of national significance. In the genus *Entoloma*, we find the same hierarchy. It should be noted that the concept of the species being broader in Great Britain and the Netherlands, the number of Wax Caps in particular is greater in France. These results should also be viewed in terms of the number of visits made to the site, but also the physical size of the site: the Motte de Nesles, a small site, is vastly richer than the Bonningues site which represents 10 times the surface area.

DISCUSSION THREADS: BIOINDICATORS AND THE UNEVEN DISTRIBUTION OF SPECIES ACROSS HILLSIDES

These results differ from other territories. Indeed, these grasslands represent important differences when compared to similar grasslands in Great Britain such as the rarity of the *Camarophyllopsis* and the *Geoglossacae* family. We also note the absence of acidophilic species and the frequency of *Cuphophyllus colemannianus* (**photo plate II**) which seems to be omnipresent on virtually all slopes, a chalky soil species par excellence which is less common in Britain. If we compare the grasslands of Boffles (Nœux-les-Auxi) actively prospected as late as the early 2000s by C. LECURU, there are fewer entolomæ, while some hygrocybes of great heritage value are present on Park territory (*Hygrocybe punicea*, *H. aurantiosplendens* and *H. calyptriformis* for Audrehem - **photo plates I and II**). The comparison with the grasslands of Lorraine (Richard's dissertation, 2000) underscores the great wealth of some Park sites. It seems that the coastal grasslands surrounding Blanc-Nez (abundance of the pair *Hygrocybe reae*/*H. fornicata* and the more rare *Microglossum olivaceum*, **photo plate I**) differ from those of the country of Licques which counts more species. The Park accounts for 80% of the chalk grassland in the region; it certainly still has treasures to reveal, especially if other, at present unknown, grasslands were to be surveyed.

*The Park accounts for **80% of the chalk grassland** in the region*

FUNGAL DIVERSITY AND MANAGEMENT STRATEGY

What are the links to be considered between the observed fungal wealth and the type of management? (see figure 1 p. 36).

In Audrehem **(see map p. 34)**, a link could be established with differential soil amendments. The steep west slope was re-appropriated for sheep pasture in 2008 and the grasslands restored by the Park. The southern sector (awarded a prize in a floral meadow competition) grazed by heifers for several decades, is by far the richest. We note however, a fungal indigence on the plateau to the east and in the valley (clearly visible on the map), explained by the fact that this plateau receives fertilizer inputs. The contrast is very clear especially in the south.

Soil amendment and site management offer an explanation for the presence or absence of wax cap mushrooms but are not always sufficient; Mont Couple, a site under extensive management for almost twenty years is devoid of high natural heritage value species.

Thus, we may conclude that management methods greatly influence outcomes, but that sites respond differently, which is where the difficulty lies in adapting management techniques to an appropriate grazing intensity.

Indeed, the most insidious threat is that of a return of *Brachypodium*. It is difficult to find a balance between historic overgrazing and the soil's modest fertility as shows the evolution of heritage species at the Audrehem site. Thus, a higher grazing pressure is being put in place on this site.

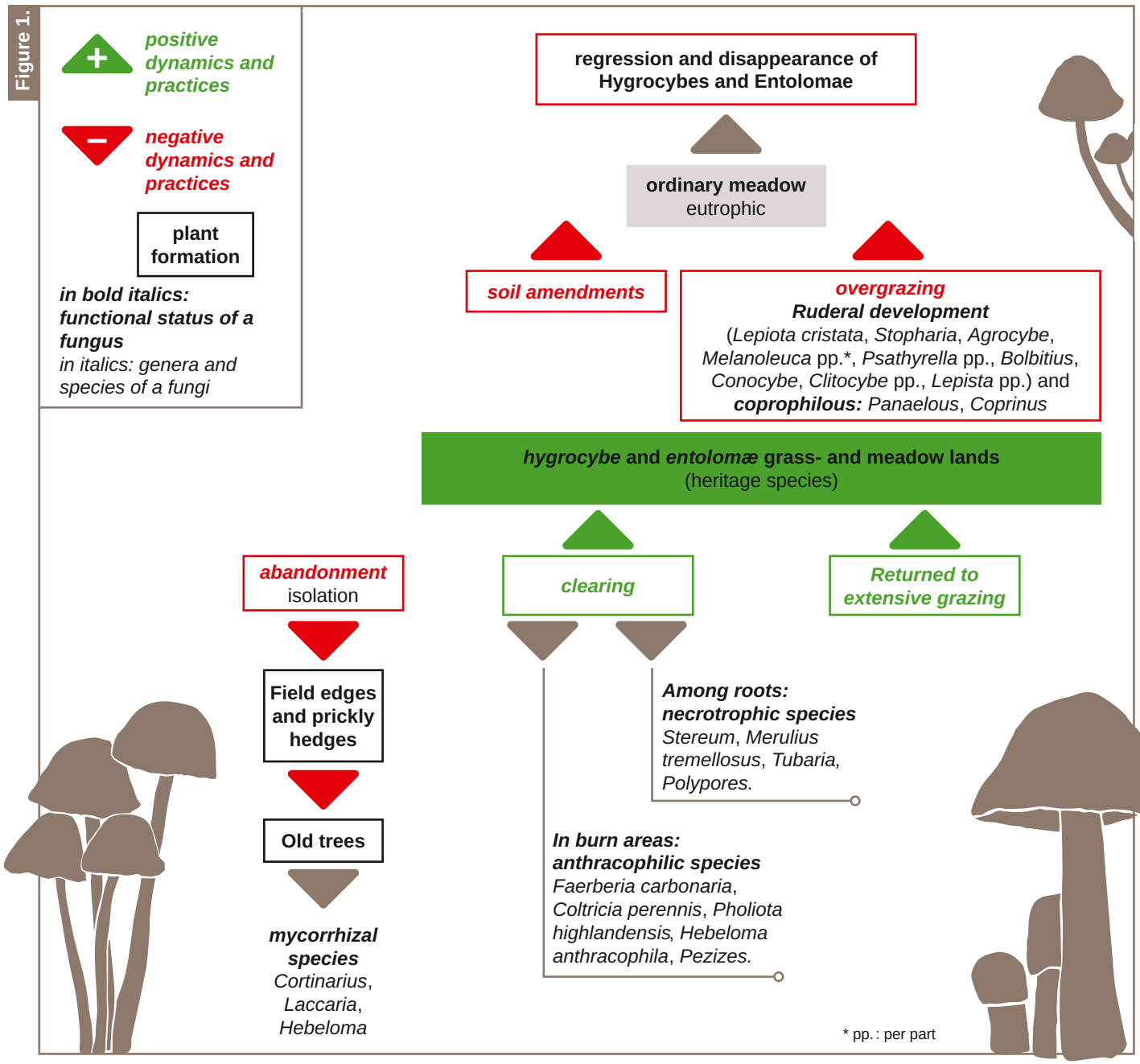
The importance of maintaining a mosaic of sites and habitats is obvious. Indeed, maintenance of copses on the hillside of Quelmes, may present certain advantages for fungi, not only insuring the presence of mycorrhizal species, but also for the protection it offers against drying winds. Also mowing and clearing overgrowth should be done with great care to leave shruby areas.

FINALLY, HOW ARE FLORAL AND FUNGAL DIVERSITY RELATED?

It was hypothesized that the wealth and diversity of fungi were linked to floral diversity. Over years of observation, it had become apparent that there was an important gap between the two, except areas with too much nitrates or closed environment rich in nitrates or in isolated fields. If we look more closely at this gap we will note that floral diversity is greater on sloping fields and shallow soil, corresponding to principally oligotrophic conditions (Orchids, *Chlora perfoliata*, *Hippocrepis comosa*, *Helianthemum nummularia*). Such slopes represent negligible fungal habitat especially in terms of the more common species. Is this a question of water resources? Of plant symbiosis and the lack of companion plants? Or is it a matter of trophic specialisation?

Two species of great heritage value find optimal growing conditions, the Blue Pinkgill, *Entoloma bloxamii* and the calciphilous *Cuphophyllus colemannianus*, and to a lesser degree the fleshy brown calciphile hygrocybes, *Hygrocybe fornicata* and *Entoloma incanum*. The extremely rare *Mi-*

Figure 1.



croglossum olivaceum (see **photo plate I**) observed on the chalky slopes around Blanc-Nez or Camiers (and pictured here with *Hygrocybe calciphila*) can be added.

The richest areas for fungi discovery finally are on less steep surfaces with deeper, water retentive soils not lacking in clay and where vegetation is more characteristic of a prairie than of a lawn. This is perfect cover for the *Hygrocybe punicea*, *Hygrocybe aurantiosplendens*, *Hygrocybe coccinea*, *Cuphophyllus pratensis*, *Hygrocybe quieta* and other *Entoloma*, including the rare *Clavaria fumosa* (smoky fairy club) amidst tall grass. It is also in this mesotrophic grassland that one may encounter the very rare *Hygrocybe calyptriformis* (Ballerina waxcap or pink meadow), *Hygrocybe flavipes* and *Hygrocybe nitrata*.

These findings echo those of British mycologists and hygrocybe specialists like Griffith, Rotheroe, Evans. In this respect Griffith underscores the fact that the greatest diversity of fungi is to be found in the "mesotrophic grasslands" more particularly in British National Vegetation Classification MG5 (*Cynosorus cristati – Centaurea nigra*) and MG6 or "semi-improved areas" more so than in CG4 (chalky soil oligotrophic groups), going so far as to say that the richest fungal habitat is where the flora is the most banal. Some authors also point out that the rare *Hygrocybe calyptriformis* is

more often found in unamended urban parks or cemeteries despite the presence of nitrates. It is also symptomatic that the nearest regional station of the latter is in the Beaumont-Hamel Newfoundland Memorial cemetery, in the Somme Department. British authors underscore **linkages between fungi and mosses**; the abundance of rare and heritage species would link closely to *Rhytidiadelphius squarrosus* (turf moss). There is a saprotrophic species of mosses and fungi, but for lack of research, we are not able to support this hypothesis. At Mount Pelé, visited in 2014, there would be even regression in areas overgrown with moss. Only the *Geoglossacae* seem to respond well in this biotope.

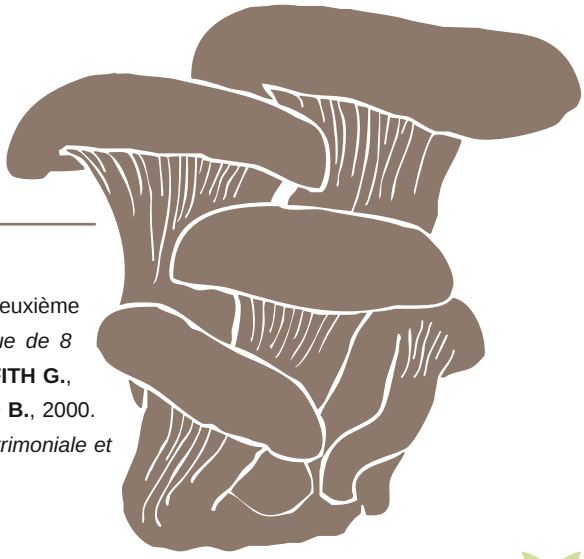
CONCLUSION

The limestone hills of the Park have proven a revelation for their rich fungi. Thus, two new species for the region, *Hygrocybe calyptriformis,* the beautiful pink hygrophore and *Hygrocybe nitrata* with its chlorinated odour were discovered there. Twenty sites were visited but there is no doubt that further exploration of regional limestone slopes will lead to the discovery of other rare fungi. It would thus be of value to contact property owners and pursue the inventory and mapping in order to identify the best methods of management suitable to fungi that are adapted to calcareous habitats. A comparison with Kentish grasslands would also be worthwhile and would be of interest not only in identifying the fungi but also in considering their management.

Furthermore, acidic grassland soils provide another subject for study because they are ubiquitous, whether in the coastal zone or inland. Thus, Ambleteuse and Dannes (Mont Saint-Frieux) grasslands display differentiated fungal landscapes. But this wealth is fragile, both in terms of adjustment and adaptation of management techniques (grazing pressure and the mosaic of habitats) and as tools for further study.

Finally, and on behalf of the fungal kingdom, mycologists generally and the members of the Mycological Society of Northern France in particular, often must intervene with property managers to affirm the autonomy of fungi as a kingdom apart. Mushrooms are too often ignored or left out of documents (posters, photographic atlases, etc.). As we have shown with this study, fungi as bioindicators are not always in tune with the richness of local flora. It was thus that when revising the Regional Park Charter in 2012, our demands for recognition of the fungal kingdom were taken into account.

Author's Note: *I would like to thank the Park for kindly including an article about fungi in this first issue of Regional Natural Park naturalist notes and facilitating the 2016 publication of a guide to the rare and threatened mushrooms of the Regional Natural Park in which the fungi of the Park' s chalky grasslands will have an assured place.*



BIBLIOGRAPHY

COURTECUISSE R., 2000. *Inventaire mycologique de la région Nord – Pas-de-Calais* (deuxième édition). **COURTECUISSE R.**, **LECURU C.**, **MOREAU P.-A.**, 2007. *Étude mycologique de 8 sites gérés par le Conservatoire des sites naturels du Nord et du Pas-de-Calais*. **GRIFFITH G.**, **EASTON G. & JONES A.**, 2002. *Ecology and diversity of waxcaps in Wales*. **RICHARD B.**, 2000. *Les mycocoenoses des pelouses calcicoles du Barrrois lorrain. Analyse inventoriale, patrimoniale et conservatoire*. **THOMSON R.**, 1997-1999. *The Sommerset grassland fungi project*.

EMBLEMATIC SPECIES OF THE MARSHLANDS

The Great or Eurasian Bittern and the Little Bittern of the Audomarois marshes


L. BARBIER[1]
A. MILLOT[2]

Abstract: Since 1995, the Parc naturel des Caps et Marais d'Opale has progressively implemented a tracking program for the nesting Little Bittern (*Ixobrychus minutus*) population in the Audomarois wetlands. This population has been documented since at least the nineteenth century. In the meanwhile, the Great Bittern (*Botaurus stellaris*) returned to nest at the Romelaëre Ponds in 1999 ending decades of absence during the breeding season. This article presents the local contexts of the Audomarois and Romelaëre wetlands and tracks the presence of these two heron species through recorded observations over a twenty year span (1995-2015).
Keywords: Little Bittern, Great Bittern, water management, reed beds, peatlands, riparian plants.

Résumé *: Depuis 1995, le Parc a mis en place progressivement un suivi sur la population de Blongios nain (*Ixobrychus minutus*) reproductrice du marais audomarois. Cette population y est connue au moins depuis le XIXe siècle. Parallèlement, le Butor étoilé (*Botaurus stellaris*) est devenu reproducteur sur la réserve naturelle des Étangs du Romelaëre en 1999 après plusieurs décennies d'absence en période de reproduction. L'objet de cet article est de présenter le contexte local du marais audomarois au travers de la présence de ces deux ardéidés et d'analyser les résultats des suivis enregistrés sur la période 1995-2015.*
Mots-clés *: Butor étoilé, Blongios nain, roselières, mégaphorbiaies, gestion de l'eau, conservation.*

INTRODUCTION

Populations of the Eurasian Bittern are in marked decline largely because of habitat loss. Wetlands drainage and human encroachments continue as important factors in these declines. The Little Bittern, smallest of the European herons, is also in steep decline as a result of disappearing habitat but also because of the high mortality rates sustained during its annual migration to wintering sites in Africa and the disappearance of suitable rest stop habitat along the fly way.

The monitoring of these populations in the Audomarois marshes is essential both for the species and in assessing qualitative changes in the marshland. Following, we first present the Audomarois habitat for the two species and the context for this study. We then present our monitoring protocols and the challenges we faced in implementing these. Finally, we present our key results as well as trends and discussion.

BACKGROUND AND BRIEF PRESENTATION OF THE TWO SPECIES

The Audomarois marsh is located midway downstream from the Aa river watershed in North Rhine-Westphalia and upstream from the Aa delta. A vast lowlands area of 3726 hectares within the meaning of the 1971 Ramsar wetlands convention, the Audomarois marsh is inhabited, and extensively cultivated. At the heart of the marsh are the historical peat bogs that generated the Romelaëre ponds, beginning in the 14th Century from the beginning of the 18th Century. Thus the physiognomy of the marsh as a whole has evolved

1. Parc naturel régional des Caps et Marais d'Opale (PNRCMO) – Maison du Parc – BP22 – 62142 Colembert – lbarbier@parc-opale.fr
2. Parc naturel régional des Caps et Marais d'Opale (PNRCMO) – Maison du Parc – BP22 – 62142 Colembert – amillot@parc-opale.fr

Map

over the centuries, but it is not always possible to describe the different steps of this evolution. Currently, the marsh is constituted mostly of wet meadowlands (approx. 1200 ha). Four hundred thirty hectares are used for market gardening. The rest of the marsh is made up of more or less homogenous natural and residential areas, forested zones, fallow fields and water bodies reserved primarily for hunting and fishing activities. Amid the labyrinthine maze of soil and water, nature still has an important place with numerous species involved in national or regional action plans, among which the Eurasian Bittern and Little Bittern.

The two herons presented share one important feature: they are exceedingly discreet and hard to spot. The birds' mottled brown plumage allows them to easily hide amid the vegetation on the banks. At the slightest alarm, they will stand erect with their beaks pointing to the sky and become indistinguishable from the background foliage. The Eurasian Bittern betrays its presence from April with a territorial call that closely resembles the guttural "booh" of blowing across an open pipe end, a sound that carries as far as a thousand metres. The bird's distinctive call has earned it a local nickname as the "marsh bull". The Little Bittern on the other hand, requires regular and diligent observation to be spotted between May and August.

The Great Bittern (*Botaurus stellaris*)

The "Great Bittern", or Eurasian Bittern, is a stocky heron between 70 and 80 cm high with a wingspan of between 1 and 1,30 metres weighing between 900 and 1,100 grams. The Great Bittern's head is topped with a crest of black feathers. Its beak and mouth are framed by black feathers passing under each eye. The mottled brown plumage with black stripes is similar in males and females and earned the bird its French sobriquet, "starred heron" (Butor étoilé). The male is slightly larger than the female and is polygamous: a single male may mate with up to five females. The Eurasian Bittern almost exclusively inhabits dense reed beds. Only the female takes care of incubation and rearing (LPO 2006).

The Great Bittern. © P. Cannesson/Biotope

Within the Caps et Marais d'Opale park territory and during the breeding season, the species is present in the Audomarois marshes, the Guînes marsh and regularly in the coastal fresh water marsh complex at Wissant-Tardinghen. Over the past decade, the Park hosted between 3 and 7 male singers on Park marshlands without a doubt the majority of the 10 or so singers identified in the Nord – Pas-de-Calais region. The Audomarois marsh hosts at least half of the singing males identified in the Region.

The Little Bittern *Ixobrychus minutus*

The Little Bittern is the smallest member of the Ardeidae (Heron) family in Europe with a height of 36 cm, a wingspan of 40-58 cm and a weight between 125 and 150 g. The

Little Bittern. © E. Demeure

first mention of the species' presence in the area dates back to June 1869, with "one adult male." A stuffed specimen is available for viewing among items of the Van Kempen Collection of the Henri Dupuis Museum in Saint-Omer (see photos below). The adult male differs significantly as it is much darker. Unlike the Great Bittern, the Little Bittern is a trans-Saharan migrant who returns to the Pas-de-Calais sometime around the first half of May to nest for as little as two months before returning south beginning in mid-July. The earliest observations recorded were made in late April and the latest in early November. In the latter case, the observations were certainly made of a bird in poor health.

Within the Park, the species has only ever been spotted in the Audomarois marsh. Occasionally they have nested, but without further recurrence in the Guînes marsh or in Belgium. Of the 20 years of assiduous birdwatching, the Little Bittern population has fluctuated between 3 and 38 possible pairs. At the beginning of the century the species experienced a comeback of sorts, a growth spurt which lasted only about a decade until 2012, when the numbers again began to decrease. In 2013 the nesting population was estimated at 3 or 4 pairs. The causes do not seem to be local, but rather to be found among the African wintering sites, some of which seem to be in a terrible state of degradation. Unfortunately, it is not possible to obtain reliable information on sub-Saharan wintering habitats.

Incidentally, the Little Bittern has become, alongside the Caps site, one of the two Park emblems.

© PNR CMO

MATERIALS AND METHODS

The complexity of the Audomarois marsh with its 3726 hectares, its 700 kilometres of water courses and 13,200 recorded parcels divided among 3950 owners, required the development of site specific protocols for inventorying the two species.

Bird watching. © PNR CMO

The Great Bittern

The site of the Romelaëre ponds had been proposed as early as the 1980s as a nature reserve. It was not until 1987 that the site was classified by the prefecture as a "voluntary nature reserve" to be reclassified in 2008 as a "National Nature Reserve". The Romelaëre site has served as an experimental site for both conservation management and for long-term monitoring of different wildlife management strategies. The site had been left to itself for a decade, leading to further colonisation by thickets of willow and blackthorn where they should have been reed beds. At the same time, the lack of a water management programme contributed significantly to ecosystem degradation and the failure of aquatic subsystems, notably for the development of helophytes.

Thus, for another decade, between 1987 and 1997, Park technicians continued ceaselessly to work on one aspect or another of the Nature Reserve, from designing and implementing programmes to limit invasive colonisation of tall grasses and reeds by shrubs to experimenting with hydrological regimes to improve water management. Over that same period a few peripheral acquisitions by the Park but also by county and regional conservation entities facilitated the consolidation of certain functional landholdings.

Reed bed. © PNR CMO

The work carried out consisted mainly of radically cutting back willows, tall grasses and reeds, beginning in mid-August. All of the organic materials thus collected were used to restore the ponds separation dikes.

The Holy Grail sought by Parks biologists was the return of the Eurasian Bittern. Its presence had been a regular feature of winter life in the area. A few birds from regional health centres were released back into the site without any sense of whether they would adapt to the area. After 15 years, efforts finally paid off when, in the spring of 1999, the song of the Eurasian Bittern was heard again among the reed beds of the Audomarois Nature Reserve. This was music to the ears of the hundreds of volunteers and Park managers who had worked hard for just such an occasion.

*The **Holy Grail** sought by Park biologists was the **return of the Eurasian Bittern.***

Following the return of the Eurasian Bittern, a long-term plan for follow-up and observation was needed. While singing males are demonstrative, it was important to ensure the presence of the species during the breeding period and to locate the territory or territories occupied. Beginning in 2007, monitoring was extended to all sectors of the marsh considered favourable with respect to the quality of the local habitat.

Bird watching. © C. Coulon.

Thus all the Sensitive Natural Areas of the Pas de Calais and Nord departments were examined, like the "cuvette de Clairmarais – Nieurlet – Noorpeene".
The implementation of this monitoring was done by Caps & Marais d'Opale park agents, EDEN 62 and volunteers from the Pas-de-Calais Ligue pour la Protection des Oiseaux and many trainees. Equipment used during these trips consisted mainly of binoculars and telescopes, but the vast majority of data were collected by listening for the distinctive male calls. Meanwhile, many other observations and bird calls were observed and recorded, all of which were catalogued and contribute to the natural heritage database of the Park and to improvement of the Park's knowledge of the marsh.

The protocol originally developed operated on the principle of triangulation, with fixed listening points located every 250 meters, the terrain permitting. Good organisation required the presence of observers at each of the ten listening stations, where possible, in pairs. The observations began in early April and lasted through mid-June. For each of the six sessions, observers would arrive on site 1 hour before sunset and stay on station for two hours. When the number of observers did not meet the planned requirement, listening stations were manned closest to areas where one or more birds had been heard on previous occasions. In terms of surface area, the territory covered was not very extensive. That plus the fact that the marsh areas conducive to Bittern foraging activities were limited, we consider that the observations collected were sufficient to present accurate annual estimates of Eurasian Bittern presence.

The Little Bittern

Up to the 1970s this diminutive heron was very common among area wetlands. The species declined in the 1970s no doubt due to the degradation of local habitat but also to the degradation of wetlands along its migratory fly way. In the Nord – Pas-de-Calais region, the resident population dropped from 80 pairs to nearly nothing two decades later. From the 1990s, regional populations showed strong signs of recovery with regional numbers rising to an estimated sixty couples [J. GODIN in Alauda 74 (1), 2006]. This improvement lasted until 2008 when the population again faced a crisis, a crisis that has continued into recent years.
These data are confirmed by Loïc MARION [MARION L.

Great Bittern

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Guînes marshes	**3**	1	1	-	**1**	-	-	-	-	**1**
Audomarois marshes	**1**	**3**	**4**	**5**	**3**	**4**	**3**	**3**	**4**	**5**
Wissant bay	**-**	**-**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**1**
TOTAL PNR	4	4	6	6	5	5	3	3	4	7
TOTAL	**4**	**4**	**6**	**6**	**5**	**5**	**3**	**3**	**5**	**7**

Little Bittern

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Guînes marshes	**-**	-	-	-	**-**	-	-	-	-	**-**
Audomarois marshes	**25**	**38**	**37**	**13**	**18**	**23**	**6**	**3**	**4**	**3**
Wissant bay	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL PNR	25	38	37	13	18	23	6	3	4	3
TOTAL	**25**	**38**	**37**	**13**	**18**	**23**	**6**	**3**	**4**	**3**

PNR: Guînes Marshes, Wissant Bay and audomarois marshes

BARBIER & C. MORIN in Alauda 74 (1), 2006]. The reasons advanced for these fluctuations are the same as always, now augmented by questions related to rainfall distribution and the sustained droughts that occur in sub-Saharan Africa since the late 1970s. More recently, alterations (drought, evaporation, pollution, whether accidental or not) seem to have contributed to the degradation of Little Bittern wintering areas in West Africa. Some authors even suggest that pollution of their European breeding sites may be a factor in explaining their decreased numbers.

Little Bittern. © A. Millot

The rarity of the species in the mid-1990s, difficulties in establishing a reliable inventory and above all, the difficulty in confirming as "certain" the presence of breeding activity, prompted the Park and GEDENA (a naturalist study group focused on the Audomarois marshes, now the Pas-de-Calais "Ligue pour la Protection des Oiseaux") in 1995 to organize a sustained watch for the species within the marshlands, basing its census protocol on the work of Nicolas Boileau, a trainee with the Park. The strategy and technique deployed in the mid-1990s continue to this day.

Population monitoring was organized as a sample trace comprising several itineraries which are alternatively followed int the morning, at noon and in the evening. Along these paths are predetermined stations for listening and observation. These itineraries have been followed for 20 years on the same basis mainly between May and August. The recorded results owe much to the confidence of private property owners who have authorized observers to access their properties during the monitoring season.

400 pairs of Little Bitterns, and 70 confirmed nest sites have been identified between 1995 and 2015

RESULTS AND DISCUSSION

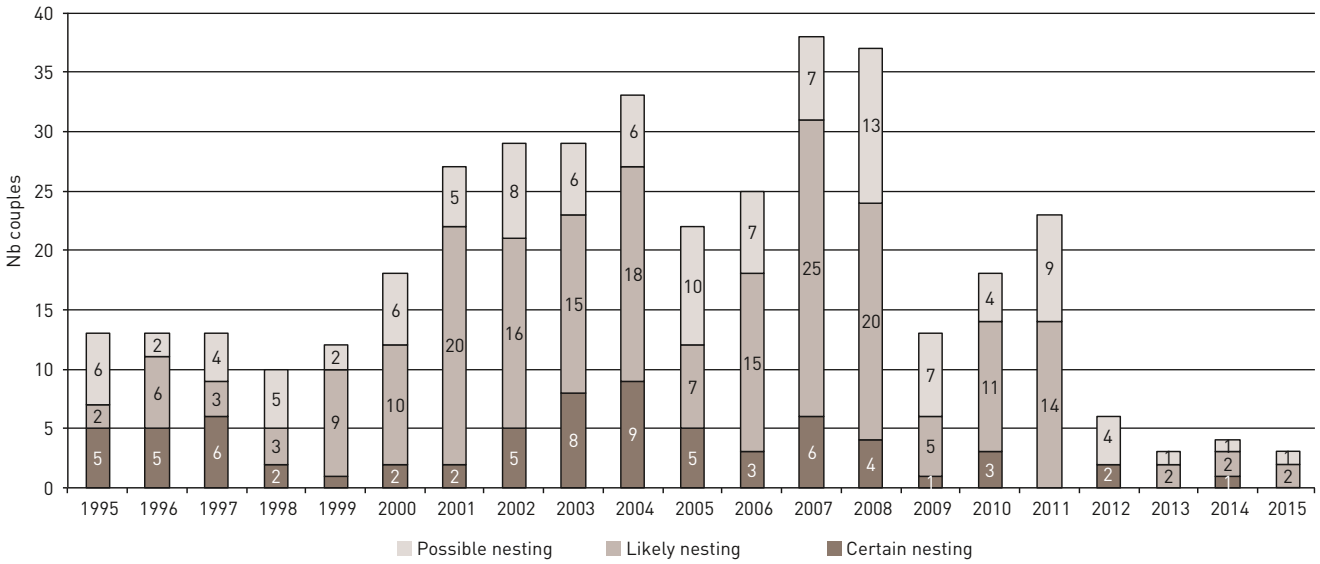
The diagram on the next page summarizes the results recorded between 1999 and 2015 for the Eurasian Bittern monitoring program. It should be noted that beginning in 2007, the survey area was expanded so that an increase in the number of singing males was recorded.

Two comments:

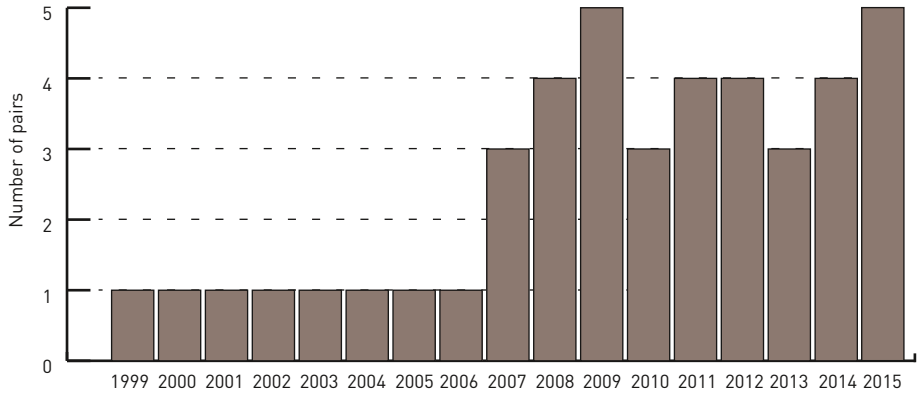
– Between 1 and 5 singers were counted annually between 2006 and 2015. There were certainly singers in the Clairmarais - Nieurlet - Noordpeene basin before 2007, but they were not included in any particular census. The high degree of variability among recordings (both in frequency and in volume) might reasonably explain the non-detection of these singers also fully present on private property;

– The population increase from 2007 is not the sole result of change in the observation perimeter. The number of singers present on the Romelaëre Ponds Nature Reserve ranged from 1 to 3 over the period.

• The Little Bittern: In the case of the Little Bittern, more



Little Bittern (*Ixobrychus minutus*) in the Audomarois marsh since 1995. Source: 2015 PNR CMO



Great Bittern (*Botaurus stellaris*) population in the Audomarois marsh since 1999.
Source: 2015 PNR CMO

than 600 observations were made in 1996 permitting a general characterisation of the breeding population of the marsh. Several nests were located and birds captured and banded (using the Museum's metal rings and coloured rings). The inventory work continues to this day with over 400 pairs inventoried and 70 confirmed nesting sites over the 20 years since 1995. To give the reader a sense of the difficulty in monitoring this species, we offer the case of a bird banded in 2001. The male Little Bittern was captured at the beginning of June. It was brood season and a brood patch clearly indicated that this bird was nesting. He was identified and tagged with a museum ring on the right leg and a Narvic blue ring on the left. He was not seen again that season or the next... Two years later he was found on a pond 250 meters from where he was captured. Over three nesting seasons and despite diligent follow-up, that bird was only seen twice.

Unlike the Great Bittern, its lesser cousin seems less demanding. Its territory is limited and it arrives in the Park at a time when the food source is present. Out of the first twenty years of observation, it appears the Little Bittern has a greater tolerance for humans, provided that its nesting site is at a safe remove. The Little Bittern's nest is frequently located in an area that is inaccessible from land, or in the heart of a thicket. Almost systematically it is located above the water. The presence of water lilies seems to be constant, as does the presence of fallen trees on the banks, both elements that appear to facilitate fishing. One of the important lessons to be learned from this monitoring has been that if, in the 1970s birds seemed to build their nests systematically in reed beds or along ditches and river banks [BARBIER in Alauda 74 (1), 2006] , almost all nests formally identified since the beginning of monitoring have been in clusters of thickets with hawthorn and brambles.

CONCLUSION

For over twenty years, the Caps & Marais d'Opale Regional Park has collected population statistics for the Bittern populations of the Audomarois marsh. These statistics offer several insights at various levels.

Tracking of the Eurasian Bittern allows us first to know the disposition of the population within the marsh. The presence or absence of this species is an important indicator of ecosystem health including such issues as the availability of water both in nesting sites in France and in Africa, the deterioration of reed bed habitat or the environment (pollution, reed beds fires in spring, cleaning out works in during the females installation period, etc.), etc. The accumulated observation data allow the park to be present among observer networks whose territories host this species. The total French population of Eurasian Bittern is estimated at 250 pairs, a large part of which are to be found in Camargue and among Mediterranean wetlands. Since 2007 Caps & Marais d'Opale wetlands hosted between 3 and 7 singing males and a total of ten within the Park territory, the main part of the region population. Tracking the bittern has also proven useful in identifying and inventorying other species that rely on the same habitat. These species include Savi's Warbler (*Locustella luscinioides*), the Bluethroat Flycatcher (*Luscinia svecica svecica*), the Spotted Crake (*Porzana porzana*), the Sedge Warbler (*Acrocephalus schoenobaenus*), among others.

The Little Bittern, adopted as an emblem of the Park, requires rigorous, year-on-year monitoring. For the Little Bittern, monitoring is a more difficult proposition than for the Eurasian Bittern simply because males are not as demonstrative. The observation pressure is thus greater and one is not always able to confirm reproduction presence within the Park marshlands. That said, it was the Little Bittern that led the Park to take the lead in the formation of a Little Bittern Study Group among French wetlands operators as a means to study the difficulties in completing verifiable Little Bittern population inventories. Private property owners became skilled observers and spotters of the Little Bittern activity.

It is the data collection and organisation for publication and sharing among professionals that has permitted the Caps & Marais d'Opale Natural Park to improve inventory and management procedures, but above all to contribute to a better understanding of those wetland species that are often confronted with conservation issues.

Alternatively, this monitoring project has allowed different observers to have a lot of fun exploring these two endangered herons and at the same time, to assist with the training of some twenty environmental engineers-in-training, and initiate a few dozen observers to bird watching.

BIBLIOGRAPHY

Alauda 74 (1), 2006 : 155-170. Statut du Blongios nain *Ixobrychus minutus* en France entre 1968 et 2004 et causes probables de l'évolution de ses effectifs. **BARBIER L. & BOILEAU N.**, 1999 – Aspects méthodologiques concernant le suivi d'une population de Blongios nain *Ixobrychus minutus*. Rapport annuel GEBN n°2 : 22-31. **BARBIER L.**, 2006 – note sur les observations anciennes de Blongios nain *Ixobrychus minutus* sur le marais audomarois (Nord – Pas-de-Calais/France). Alauda 74 (1) : 60-64. **BOILEAU N. & BARBIER L**., 1997 – Étude et suivi d'une population de Blongios nain Ixobrychus minutus sur les étangs du Romelaëre (Pas-de-Calais) en 1996. Alauda 65 : 343-350. **DELELIS N. & BOIN S.**, 2006 – Typologie de l'habitat du Blongios nain *Ixobrychus minutus* dans le marais audomarois (Pas-de-Calais). **Alauda 74** (1) : 65-75. **GÉROUDET P., OLIOSO G.** (2009) – Grands échassiers, gallincacés, râles d'Europe – Delachaux et Niestlé. 490 p. **GODIN J. *in* Alauda 74** (1), 2006 : 85-93. Le Blongios nain *Ixobrychus minutus* en Nord – Pas-de-Calais : distribution des nicheurs et effectifs de 1968 à 2004. LPO 2006, Recueil d'expériences du programme LIFE Butor étoilé : biologique et gestion des habitats du Butor étoilé en France. LPO 2006, 96 pages. **MARION L.**, **BARBIER L. & MORIN C.**, 2006 – Staut du Blongios nain *Ixobrychus minutus* en France entre 1968 et 2004 et causes probables de l'évolution de ses effectifs. Alauda 74 (1) : 155-170. **HUNAULT S. & KERBIRIOU E.** (2007) – *Le Butor étoilé Botaurus stellaris ; Plan national de restauration 2008-2012* – Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer – Ligue pour la Protection des Oiseaux. 110 p. **MILLOT A**. (2012) – Synthèse de la mise à jour de l'occupation du sol du marais audomarois – Parc naturel régional des Caps et Marais d'Opale. 13 p. **MILLOT A.** (2014) – *Synthèse naturaliste du marais audomarois, 2014* – Parc naturel régional des Caps et Marais d'Opale. 31 p. **THORIS M., BARBIER L., MILLOT A.** (à paraître) – Statut du Blongios nain (*Ixobrychus minutus*) en France entre 2005 et 2012 et causes probables de l'évolution de ses effectifs. 17 p.

species

habitats

corridors

A flowering strip from the Agrotrame project in Guînes

© PNR CMO

BIRD MIGRATION

The importance of coastal corridors along the Channel and North Sea



F. CALOIN[1],
G. FLOHART[2],
P. REDMAN[3]

Abstract: Bird migration is a fascinating subject and the Parc naturel régional des Caps et Marais d'Opale is ideally situated for observation. The regional strategy for tracking bird movements operates primarily through seawatch and through banding, two strategies that contribute to improved tracking data and observation of changes in the phenology of migration. The article presents results for three species: the Balearic Shearwater, the Common Scoter and the Aquatic Warbler.
Keywords: Migrating bird species, Pas de Calais. Strait of Dover, seawatching, banding.

***Résumé**: La migration des oiseaux est un phénomène qui fascine ; la localisation du Parc naturel régional des Caps et Marais d'Opale est particulièrement stratégique pour l'étudier. Le suivi en région s'opère principalement par le seawatch et le baguage ce qui permet de contribuer à l'amélioration de la connaissance et à l'observation de modifications dans la phénologie de la migration. L'article présente également un zoom sur les résultats obtenus pour trois espèces : le Puffin des Baléares, la Macreuse noire et le Phragmite aquatique.*
***Mots-clés**: Avifaune migratrice, détroit du Pas-de-Calais, seawatch, baguage.*

INTRODUCTION

Migration has always fascinated the sedentary species that we have become. The procession of flocks and the millions of birds that each year travel hundreds and thousands of kilometres, remain a sight that is both fabulous and mysterious. Following the Second World War, with the advantage of improved optics and the democratisation of the automobile, European ornithologists began to more actively follow this phenomenon from geographically advantageous sites. Moved by a desire to improve society's knowledge of migration and nature's ways, scientific banding was born in the late nineteenth century and spread rapidly in the twentieth century as a scientific cooperative movement. The central position of the Nord – Pas-de-Calais region on Europe's north-western façade made the area of particular interest for monitoring these movements. Indeed, the Channel straight acts as a thirty-two kilometre wide funnel favourable to observation of coastal migration routes, but also a crossroads where migratory land birds from the UK, Scandinavia, the Baltic countries and more widely from all Western Europe.

1. Cap Ornis banding – caloin.fred@gmail.com
2. Groupement Ornithologique du Nord (GON) – guy.flohart@orange.fr

Birding sites along the channel coast Map

CONTEXT

In 2012, a project initiated by the Caps et Marais d'Opale Regional Natural Park and funded by the Nord – Pas-de-Calais regional council and the European Regional Development Fund (ERDF) compiled and analyzed data from different types of monitoring carried out along the Pas-de-Calais coast. The two-year cooperative project brought together a number of associations concerned with bird migration and resulted in a beautifully illustrated book, *The Migration of Birds along the Pas-De-Calais - Synthesis and Analysis of Recent Data.* This unique work of national interest combined banding and seawatch data with a comparative tableau of prenuptial migration numbers (January to June) gathered from observations made at Cap Gris-Nez and from Dungeness on the English side of the Channel. The process allowed the collation and comparison of millions of data points collected by many enthusiasts and is proving to be an important basis for improving the surveys. This work, including 120 monographs, is available in English as an e-book.

MONITORING IN THE REGION: MATERIALS AND METHODS

In the region, two old-established monitoring strategies have been employed and these have produced interesting results: seawatch, offshore bird-spotting and banding. Land

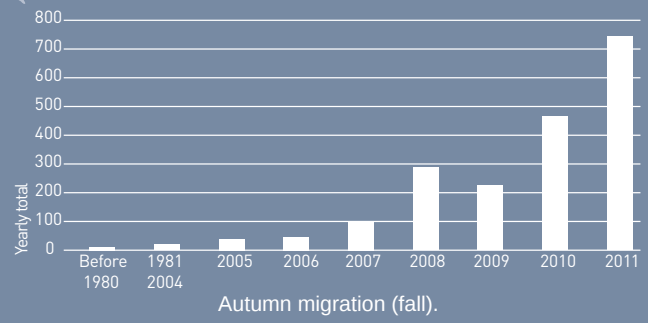
Seawatchers group at Cap Gris-Nez. © Y. Dubois

spotting and inland migrations (passerines, raptors, etc.) generally are followed differently according to regional birding culture and the available data are too partial to be exploited.

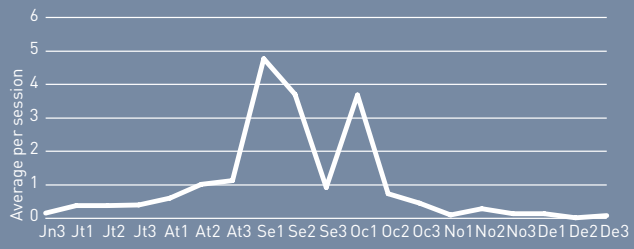
The seawatch method is to identify and count migrating offshore birds, often from sites that are geographically well located (an elevated view over narrows, from the end of a pier). This monitoring essentially concerns pelagic species (species like the Gannet) that prefer the open sea, coastal seabirds (such as Common Scoter) and various shorebirds (such as waders, terns and Anatidae). Within the region, two sites have been subject to extensive usage, the now inaccessible Clipon seawall and Cap Gris-Nez. Both are considered hotspots for monitoring of marine species migration in Europe. Although monitors have collected data for years 1955 to today, the latest, most complete time series begins from 2005. Since 2005, Cap Gris-Nez amounted to an average of 600 hours of tracking per year spread over the spring and fall migration periods.

Banding is a more technical method that can be performed only by a few skilled birders. The object is to capture the birds and tag them, usually using metallic rings. In the region, migration studies using tags are most often undertaken on passerines (although other groups of species may

Sample results: The Balearic Shearwater



Autumn migration (fall).

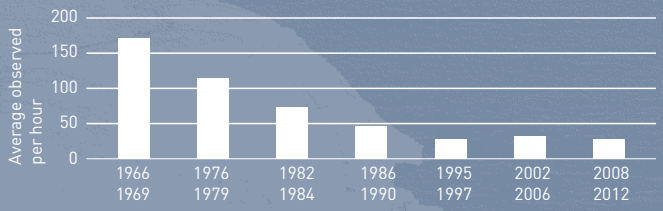


Autumn migration (fall).

Balearic Shearwater.
© L. Scalabre

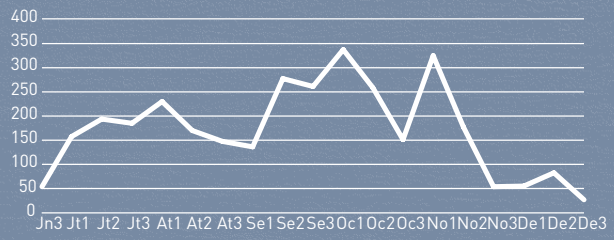
The **Balearic Shearwater** is a species for which migration changes over the past few years have been particularly noticeable. Prior to the 1980s, observations of this species in the straights were at best occasional. Today this species is sighted regularly and in significant numbers. For at least 10 days each year it is sighted in numbers in excess of 50 individuals recorded almost every year. This bird, classified as "critically endangered" by the International Union for the Conservation of Nature (IUCN, 2010) nests among the Balearic Islands. After nesting, birds move to the Atlantic Ocean (Bay of Biscay). For the past fifteen years, these birds have gone north, up the Eastern Channel (Northern Brittany, south Cotentin). This change in the distribution of the species coincides with the warming of surface waters in the Bay of Biscay and English Channel, reflecting warming induced changes throughout the food chain, from plankton to fish and top predators, which, like the Balearic Shearwater, eat fish (Luczak *et al.*, 2011). These birds, sometimes nesting by the thousands off the Breton and Norman coasts, may on occasion of sustained southwest winds, be blown out to sea and in particular up to the North Sea as shown by the seawatch data collected at Cap Gris-Nez.

Sample results: The Black Scoter



Number of individuals observed at Cap Gris-Nez (post-mating season migration)

Black Scoters. © F. Caloin



Average number of individuals sighted per session (autumn, post-mating season)

By contrast, the **Black Scoter** (and to a lesser extent, the Velvet and Eider Scoters) is a species for which recorded observations have fallen sharply in recent years. The average post-nuptial passage (fall) of this maritime duck observed from the Cap Gris-Nez, Pas-de-Calais, have been reduced by a factor of 20 in over the past 50 years, even if the numbers seem to have stabilized since 2007 albeit at an extremely low level. There are several possibilities to explain this very large drop: the confirmed decline of the European breeding population (Wetlands International, 2012). The same significant decrease was noted significantly in the Baltic Sea (-47% between 1988-1993 and 2007-2009), together with the displacement of foraging activity well to the north of the traditional wintering grounds. Together these factors explain (at least in part) the very substantial decrease in population numbers spotted at Cap Gris-Nez in the fall.

be banded at other times). Between 4 and 6 banding sites are active each year on the coast of Pas-de-Calais. These include, for example, the dunes of the Slack in Ambleteuse, the Fort Verde dunes in Calais or the Mont Saint-Frieux dunes in Dannes. In this way, between 40,000 and 55,000 birds are marked each year in the region. Although some banding stations will operate in the spring, most activity takes place in the autumn, between mid-July and mid-November. If we dispose of data going back to the 1960s, systematic migration monitoring series only go back as far as 2000 while the most comprehensive time series extends from only 2003.

Banding operation. © I. Prudhomme

RESULTS AND DISCUSSION

Three types of information are tracked through monitoring:

– Improved knowledge of migratory stopover sites among wintering sites (banding);
– Identification of migratory phenology;
– Changes in migratory phenology (variation in the dates of migratory passage);
– Changes in migratory behaviour (changes in migratory patterns);
– Changes in overall numbers.

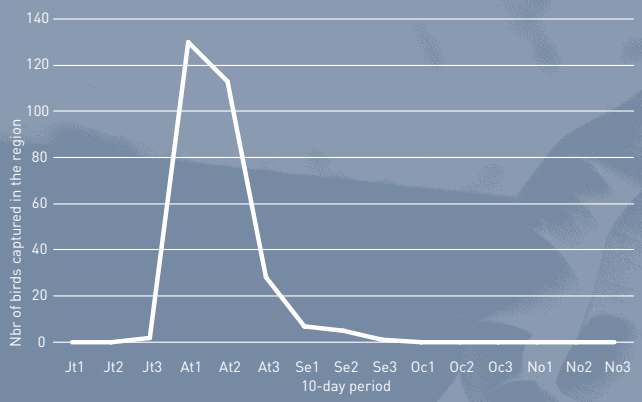
These data are sufficiently detailed to provide insights into migratory changes result-

ing from globalized warming trends or human induced changes.

Nonetheless, regular follow-up over sustained periods is necessary to average out the year-on-year variability due to weather conditions for example. The fact of accumulating data from multiple sites statistically smoothes error introduced by site specific conditions.

At sea during a shared club outing. © PNR CMO

Sample results: The Aquatic Warbler



Post-breeding season migration (autumn).

The Aquatic Warbler is one of the most endangered species in Europe. The additional strip on the crest allows it to be differentiated from the Sedge Warbler. © M. Ghislain

The **Aquatic Warbler** is the most threatened passerine in Europe. In a century, its numbers have decreased by more than 90%. This species nests in Poland and is very discreet when, during autumn migration, it migrates via the Pas-de-Calais coastline. A specific capture protocol was established in 2007 to address questions about population numbers, migration patterns and migratory stopover habitat. Thus, with over a dozen sites sampled in the region, three sites seem to be especially favoured by this species: the Wissant marsh complex, the Guînes marshes and the land-side environment of the Merlimont dunes. These captures also clarified the species' regional phenology.

Exchange day on migration. © PNR CMO

CONCLUSION AND PERSPECTIVES

The tracking data collected for the region in recent years are far from being fully exploited. Some data require more detailed statistical analysis, others require more time, in order to provide a more stable time series. We should allow the monitoring work to continue.

By organizing a two-day colloquium on "avian coastal migration" in the spring of 2014, the Caps & Marais d'Opale Park facilitated a first exchange between the different actors involved in the monitoring of bird migrations along the Channel coast. The colloquium was attended by French, English, Belgian and Dutch ornithologists in view of exploring prospects for collaboration especially between the French and English monitoring stations on either side of the Channel.

BIBLIOGRAPHY

CALOIN. F. (coord.), Cap Ornis Baguage, Station ornithologique du cap Gris-Nez, GON, PNR Caps et Marais d'Opale, 2014. – La migration des oiseaux sur le littoral du Pas-de-Calais. Synthèse et analyse des données récentes. Biotope, 204 p. **DUBOIS P.J**., **DECEUNINCK B.**, 2013. L'avifaune française et le changement climatique : espèces indicatrices. LPO/SEPN. **JAFFRE M.**, **Beaugrand G.**, **Goberville E.**, **Jiguet F.**, **Kjellén N.**, **Troost G.**, **Dubois P.J.**, **Leprêtre A.**, **Christophe Luczak Ch**. , 2013. – Long-term phonological shifts in bird migration and climate. Nature Climate Change, à paraître. **LUCZAK C.**, **BEAUGRAND G.**, **JAFFRÉ M.** & **LENOIR S.**, 2011 – Climate change impact on Balearic shearwater through a trophic cascade. Biology Letters 23, pp. 702-705. **YÉSOU P.**, T**HÉBAULT L.**, **FÉVRIER Y.**, **FORTIN M.**, **DENIAU A.**, **DOURIN J.-L.** & **MAUVIEUX S.**, 2012 – Recent insights in the distribution and abundance of Balearic Shearwater *Puffinus mauretanicus* off Brittany, western France.

AGRICULTURE and the ECOLOGICAL CORRIDOR in Guînes


M. BOUTIN[1], K. PETIT[2], S. OSTE, C. DEVIGNE[3], B. VANHEE, P. DEVILLE, C.PERNIN, F. GRUMIAUX[4]

Agricobio, *the role of flowery strips and hedgerows in crop protection*

Abstract: A farmer in Guines has developed an ecological corridor via a network of flower strips and hedges totalling almost 3 hectares across an expanse of 50 hectares. Although the effects of such infrastructures are described in the literature, their acceptance on working plantations has been limited.

The Parc naturel régional des Caps et Marais d'Opale partnered with the local scientific community and the local university to operate a research project under real farming conditions and to set up the site as an observatory for long-term monitoring of the effects of enhanced biodiversity and agricultural production. This article reviews the results of the first three years of observation and reports the effects of beneficial insects on plant cultures, the presence and variation of mesofauna, earthworms and microfauna and the increased incidence of hedgehogs.

Keywords: Enhanced biodiversity, macrofauna, microfauna, plant symbiosis, ecological corridor, flower strip, hedges, field crops.

***Résumé**: Un agriculteur de Guînes a développé un réseau de bandes fleuries et de haies totalisant près de 3 hectares sur une plaine de 50 hectares de grandes cultures. Bien que les effets de tels aménagements soient décrits dans la littérature, leur développement par les agriculteurs reste relativement faible. Le Parc naturel régional des Caps et Marais d'Opale s'est rapproché de partenaires scientifiques et universitaires pour mettre en œuvre un projet de recherche en conditions réelles d'exploitation et de faire de ce site un observatoire pérenne des interactions entre la biodiversité et la production agricole. Dans cet article, sera abordée une partie des premiers résultats après 3 années de suivi : les insectes auxiliaires de cultures, la mésofaune du sol, les vers de terre, les micromammifères et le hérisson.*

***Mots-clés**: Biodiversité, auxiliaires, bandes fleuries, haies, grandes cultures.*

1. Parc naturel régional des Caps et Marais d'Opale (PNRCMO) – BP 22 – 62142 Colembert – mboutin@parc-opale.fr
2. Fédération Régionale de Défense contre les Organismes Nuisibles (FREDON) Nord – Pas-de-Calais 21 et 265, Rue Becquerel – BP 74 - 62750 Loos-en-Gohelle – karine.petit@fredon-npdc.com
3. Université Catholique de Lille, Faculté de Gestion, Économie, Sciences – 60 boulevard Vauban 59000 Lille – cdevigne@icl-lille.fr
4. Laboratoire Génie Civil et géo-Environnement, Université des Sciences et Technologies de Lille (USTL) - Cité Scientifique 59655 Villeneuve-d'Ascq Cedex – Fabien.Grumiaux@univ-lille1.fr

INTRODUCTION

The role of the hedge as a regulator of local conditions, as a catchment for runoff in agricultural landscapes and as habitat for auxiliary fauna, has long been recognized scientifically (INRA, 1976). The value of grassy strips along the margins of cultivated areas has been documented since the late 1990s (Lagerlöf and Wallin 1993; Kromp, 1999) and has been the subject of numerous studies over the last decade (Dale and Polasky, 2007 Billeter *et al.*, 2008), emphasizing their importance not only in terms of maintaining or restoring "useful" biodiversity (preservation of auxiliary fauna) but also as a means of filtration for polluting elements and as a means to mitigate erosion and nutrient loss (De Snoo, 1999; Tsiouris *et al.*, 2002; Dorioz *et al.* , 2006). We are nonetheless far from a generalized agricultural use of grass strips.

The Agricobio trial project was facilitated by a farmer who operates a network of hedgerows and flowering strips totalling 3 hectares on two cultivated plots totally, respectively, of 17 and 33 hectares. The farmer's objectives are to protect the soil and promote the role of auxiliary cultures. Unique in the territory of the region, this experience has attracted the interest of several research laboratories committed to making this site a permanent observatory for the links between agriculture (field crops) and biodiversity under real operating conditions. The many questions arising from this field trial can be grouped around three issues:

- How does biodiversity contribute to the colonisation of cultivated fields?
- What are the specific linkages between biodiversity and local cultures?
- How can land use strategies based on hedgerows and flowering strips be adapted to serve as ecological corridors?

Biodiversity is observed through several groups chosen for their representativeness of the environment and related issues:

- Mesofauna (springtails and soil mites, etc.) are fine indicators of changes in soil quality;
- Earthworms (Oligochaeta) are critical in maintaining soil nutrients and recycling organic matter;
- The auxiliary pest complex is studied through the populations of ground beetles, hoverflies, lacewings and ladybugs but also through the hedgehog;
- Finally, small mammals were also chosen for study as their interactions with crops provide useful indicators of crop success.

STUDY DESIGN AND PRESENTATION OF THE SITE

The various factors that influence the development of biodiversity are:

- Soil type: three soil types are represented in the sector: loam, clay and loam mixed with chalk and clay and loam soils mixed with flint;
- A variety of hedges ranging from natural alignments mainly of blackthorn (*Prunus spinosa*) and recently planted hedges of local species of trees and shrubs selected to meet land use objectives;
- Flowering strips seeded with local grasses and alternating with crop rows;
- Agricultural practices which include hand sowing as opposed to mechanical tilling;
- Crops and crop rotation.

Twelve neighboring farms volunteered and thirteen control plots were chosen for comparison with the test site (see **figure 1** below). The participating laboratories then developed specific protocols for response variables: choice of plots, equipment, etc.

MATERIALS AND METHODS

MONITORING ACTIVE SOIL FAUNA

Soil mesofauna

Three samples were taken from each of the parcels studied, in the Spring of 2011 and again in 2012. The samples were collected using a core sampler (Ø 15 cm × H 20 cm) to a depth of 5 cm and extracted from the core sample using a Berlese Tullgren funnel over 10 days. Springtails were identified at the species level (Hopkin, 2007) and mites at suborder level: Oribatida, Actinedida and Gamasida (Krantz, 1978). Taxa moreover, were grouped according to vertical distributions. Three zoological types were identified according to morphological, anatomical and ecological criteria (size of the individual, optical regression, coloring, the presence or absence of a furcula or springing organ) and classified according to whether the fauna were epi-, hemi- or eudaphic. Prior evaluation of these groups allowed us to understand a species' resilience, epidaphology and capacity for dispersion. (Ponge *et al.*, 2006).

Earthworms

A sample comprising 3 or 5 samplings was taken from each of the parcels studied. Samples were drawn from an area

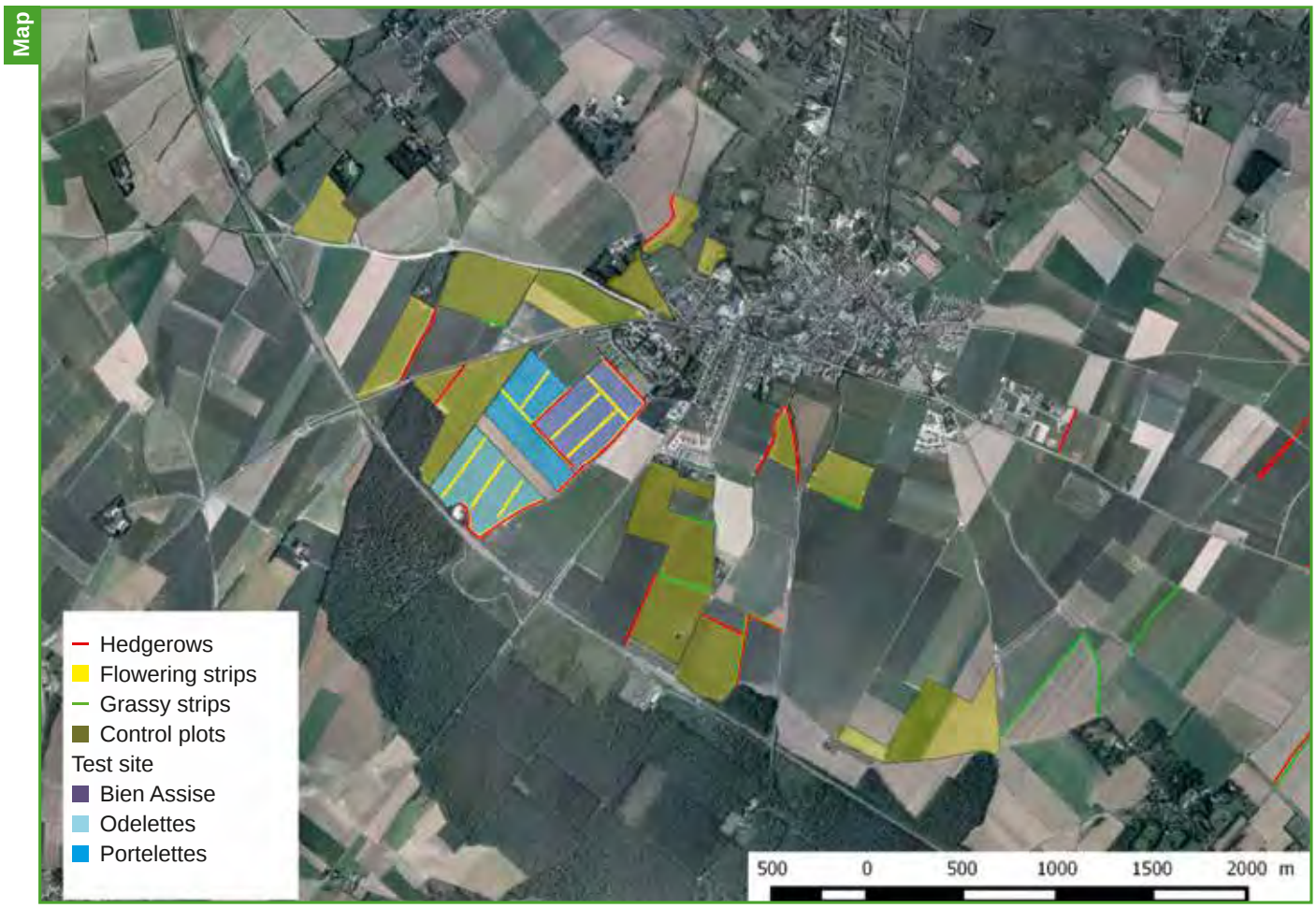


Figure 1: Location of the Agricobio test site, showing control plots (source: PNRCMO 2014)

of 0.36 m² using a method that combines chemical extraction (Zaborski, 2003) and manual sorting. The surface was irrigated twice with 5 L of a solution of allyl isothiocyanate (AITC) (1 g of AITC dissolved in 100 ml isopropanol / 10 L of water) at a 10 minute interval. Emerging earthworms were collected for 10 minutes after each irrigation. Each square was then dug to a depth of 20 cm and the remaining worms were collected and manually sorted. Earthworms counted and weighed were stored in ethanol at 95° pending identification using Bouché (1972) and Sims and Gerard (1999) identification keys. Earthworms were also classified into three ecological categories (epigeic, endogeic and anecic), based on their morphology (size, pigmentation), feeding behavior and ecology (longevity, predation) (Bouché, 1972).

MONITORING OF CROP AUXILIARIES, INCLUDING CROP PESTS

Crop auxiliaries against aphids

Three modes of observation were retained for aphids and associated auxiliaries (hoverflies, lacewings and ladybugs): Trapping using bright yellow bowls (Ø 27 cm × H 9 cm) attached to a stake and positioned at the height of the surrounding vegetation, trapping with a D-vac (an insect vacuum), and via direct observation on plants. Eight areas were monitored in 2011, 12 in 2012 and 6 in 2013. Yellow bowls were used on six different occasions over summer dates between May and August. Sampling using the insect vacuum was conducted over five dates in 2011 (between June and September) and on two dates respectively in 2012 and in 2013, between May and July, the period of greatest aphid activity. Weekly counts were made according the BSV protocol (equivalent of the Crop Monitor in the UK) on wheat and rapeseed crops from the end of May to the end of July for both 2012 and 2013. The samples collected using yellow bowls and the insect vacuum were placed in 70° alcohol and then sorted and identified at the FREDON Nord – Pas-de-Calais - Picardie Entomology Laboratory. The identification keys used in sorting hoverflies were those of Speight and Sarthou (2011 and 2013) and for ladybugs, those of Baugnée and Branquart (2000).

Ground beetles, meanwhile, were sampled by establishing of transects of 5 × Ø 60 mm Barber pitfall traps. Transects were laid out in study plots both in the cultivated fields and in the flowering strips and grassy covers. Ground beetles were identified using identification keys from the section on beetles in *Faune de France* (Coulon *et al.* 2011a and 2011b). The abundance of each species was also noted. In 2011, five sampling campaigns were conducted between June and September. In 2012, the protocol was observed only for the month of June.

Small mammals and hedgehogs

The study of small mammals was conducted using the temporary trapping method (with release on site). Selection of the sampling sites took into account the territory's potential in terms of hosted fauna, the presence or absence of landscape elements on cultivated fields including flowering strips and hedges. A total of 16 transects were laid out, with fifteen traps set in each transect. The INRA type "trip-trap" and Barber traps were set in the evenings around 7pm and monitored every two hours until 1am. Each transect was surveyed 3 times between May and August for each of the three years of the survey.

In all, three hedgehogs were equipped with micro-transmitters. One individual has been very quickly lost. The other two individuals generated a total of 25 observations (day and night) between August and October 2013.

RESULTS AND DISCUSSIONS

MONITORING OF FUNCTIONAL SOIL FAUNA: MESOFAUNA AND EARTHWORMS

Soil mesofauna

For all of the transects studied, the mesofauna were dominated by mites (70.5%). Springtails represented 22.0% of the population samples and various other microarthropoda, 7.5%. These proportions were relatively similar across all stations. A total of 40 species of springtail were identified, 27 at the edge of cultivated zones, 24 among the flowering grassy strips, 20 among wooded areas, hedgerows and crop cultures.

The diversity of taxa was significantly greater in wooded areas than in cultivated field transects. Springtails were represented by three taxa that together accounted for almost 60% of all springtails collected, among which the most common were the *Lepidocyrtus cyaneus* (27.6%), *Isotoma viridis* (16.5%) and *Isotomurus* sp. (14%). Among the 40 taxa considered in this study 14 were defined as epidaphic, 14 as

Dormouse. © PNR CMO

Vole. © PNR CMO

Hedgehog. © PNR CMO

hemidaphic and 12 as eudaphic. Epidaphic springtails were significantly more abundant on flowering strips of natural cover than they were either in the wooded areas or among cultivated crops. Only eudaphic springtails were more abundant in wooded cover. These results are consistent with those reported in Ponge *et al.* (2006) and in Cluzeau *et al.* (2009a) showing that species with high dispersal ability, characteristic of epidaphic springtails favored in open systems, grasslands and crops as opposed to closed forest systems.

The communities identified in the various environments (hedges, flowery strips and crop cover) are comparable with each other in terms of species composition. Only their density varied with the more abundant communities being found in the flowery strips and hedgerow environments.

Earthworms

In test parcels and associated natural cover strips, eight earthworm species were identified, two epigeic species (*Lumbricus castaneus* and *L. rubellus*), four endogeic species (*Allolobophora chlorotica*, *Aporrectodea caliginosa*, *A. icterica* and *A. rosea*) and two anecic species (*Aporrectodea longa* and *Lumbricus terrestris*). The soil-dwelling, endeic and the tunneling anecic species are common in cultivated fields (Decaens *et al.*, 2003; Decaens *et al.*, 2008; Pelosi *et al.*, 2014.), the *Lumbricus castaneus* and *L. rubellus* being species that prefer moist soils rich in organic matter (Sims and Gerard, 1999). Large numbers of *L. castaneus* were occasionally noted in the test parcels among flowery strips where permanent cover allows moisture build-up in the soil and a greater abundance of organic matter (leaves or straw for example). Densities were generally higher in areas with natural grass or hedge cover (between 20 and 277 individuals per square metre) as opposed to between only 6 and 115 individuals per square metre under crop cover. By expanding the area of study, we added four species to the list: two soil-dwelling species (*Octolasion cyaneum*, *O. lacteum*) encountered with low frequency and two epigeic species (*Dendrobaena octaedra* and *Satchellius mammalis*) both of whom prefer forest habitats and forest litter rich in organic matter (Sims and Gerard, 1999). Thus, the ecological niches of the study area (fields, flowery strips, grassy strips, forest edges, hedges) accounted for a certain amount of species diversity including 12 of the approximately 30 species of earthworm found in the region (Bouché, 1972).

Agricultural activities can have dramatic effects on soil invertebrates (Hendrix and Edwards, 2004). Thus, densities and diversity generally have lower values in cultivated soils than they would in undisturbed soils (Paoletti, 1999; Curry *et al.* 2002). Death due to mechanical cultivation, increased predation, soil compaction, the use of biocides, lack of organic nutrients, limited moisture are factors known to impact worm populations on lands subjected to intensive cultivation (Metzke *et al.*, 2007). This is what we can observe in fields located outside the test parcels (planted in potatoes and linen) and, to a lesser extent, in the *Bien Assise* parcel where, even if cultivation practices are reasonable, the soil is subject to sever depletion due to the intensive cultivation of such crops as potatoes, beets or green peas. In this test parcel, specific densities and diversity were lower than in the *Odelette* parcel where tillage was shallow and by extension, less harmful to the diversity of the anecic and endogeic earthworm communities. Thus, as shown by Decaëns *et al.* (2008), land use and cultivation practices have a significant impact on the diversity and abundance of species. For the study parcel, the three ecological categories of worms were present in the flowery strips and to a much lesser extent, in the cultivated parts of the field under crop cover. So there exists among earthworm communities of the site, a diversity which assists in maintaining functional soil processes.

The density of ***earthworms in the flowery strips is more than twice the density of earthworms in the crop cover transects***

MONITORING AUXILIARIES AND CROP PESTS

Auxiliaries in the fight against aphids

2011, 2012 and 2013 were relatively pest free in terms of local cereal and rapeseed cultures Very few aphids were observed, with the result that even fewer auxiliaries were observed on crop foliage. This low biological pressure reflects the unfavourable weather conditions particularly during the summer months.

Ladybugs and lacewings

In 2012, ladybugs and lacewings were present in significant

numbers in ancillary structures (grassy strips, hedges and woodlands), and little or not at all present in crop areas, confirming the reservoir effect of the ancillary structures. In 2013, low numbers were recorded. Aphidophagous beetles captured in 2012 and 2013 were: *Coccinella septempunctata* (50 individuals), *Adalia bipunctata* (2 individuals) and *Propylea quatuordecimpunctata* (1 individual). Some mycetophagous species were also captured: *Psyllobora vigintiduopunctata* (15 individuals) and *Tytthaspis sedecimpunctata* (8 individuals). As for lacewings, two species were identified in 2012: *Chrysoperla affinis* and *Chrysoperla lucasina*, the latter being a new species for the area referenced.

Hoverflies

Between 2011 and 2013, 2936 hoverflies were captured using yellow bowls and insect vacuums. Captures in 2012 and 2013 confirmed that hoverflies were found with greater frequency among plant covers (i.e., grassy covers, hedges, wooded areas…): 312 hoverflies were captured in the horticultural settlements in 2012 against only 113 in crop areas. The same observation for 2013 produced 960 and 546 respectively. This highlights the role of such diversified areas as reservoirs of helpful biodiversity. It was interesting to note that hoverflies were especially attracted to diversified covers characterized by flowering plants.

Twenty-three syrphid species were identified, 17 of which preyed on aphid larvae. Among aphidophagous hoverflies, *Episyrphus balteatus* was the dominant species on the control plots in 2012 whereas *Eupeodes* dominated the test sites. In 2011 *Sphaerophoria scripta* was dominant across all sites. In 2013, the genus *Platycheirus* dominated all sites.

Seven-spotted ladybird (*Coccinella septempunctata*). © FREDON

Marmelade hoverfly (*Episyrphus balteatus*). © FREDON

Common Hoverfly (*Eupeodes luniger*). © FREDON

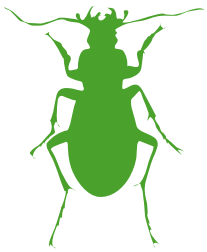
The proportion of saprophagous hoverflies varied greatly from year to year. In 2011, there were 82% fewer saprophogous hoverflies than aphidophagous hoverflies whereas in 2012 and 2013 saprophogous hoverflies where more than twice as numerous as the aphidophagous flies.

With respect to the distribution of syrphid species origi-

nating in the marshes and local woodlands, it is noteworthy that we were able to capture among horticultural settlements or crops, hoverflies known to prefer woods and wetlands. In this way, were found individuals of various species, including the *Dasysyrphus albostriatus* a known woodland species whose larvae are aphidophagous the wetland species, *Tropidia scita*, whose larvae are saprophagous , and the woodland species *Xylota sylvarum* and *X. seignis*, both of which are saprophagous.

Ground beetles

Over two years (2011 and 2012) 7592 beetles were collected in the observation space of which 7570 were identified to species level. Sixty-six different species were observed, including 60 species on the test site. The three main species present in our sampling were *Pterostichus melanarius* (41.6%), *Poecilus cupreus* (10.75%) and *Metallina lampros* (9.72%). These three species are known to be ubiquitous, have wide geographical distribution and are relatively dominant in agricultural environments. This environment in fact, corresponds fairly well to their preferred habitat, lifestyle and diet.



***66 different species of ground beetle were observed** at the study site*

In 2011, a first analysis performed on samples from the entire area (both the test site and neighbouring control fields) confirmed that beetle populations will self-select according to vegetation cover. In this sense, we identified a clear difference between beetle populations in enclosed spaces (woodlands and shrub areas) and those better adapted to open spaces (fields and grassy areas). If we examine the study site in greater detail, we can see a net differentiation of beetle populations according to ground cover. Only one year after the establishment of flowery strips, observed beetle populations differed according to ground cover with only occasional overlap among the ubiquitous species. Analysis of beetle samples taken in June 2012 (two years after the establishment of flower strips) show undifferentiated populations between specimens collected among grassy strips and fields at least within thirty metres from the strips.

The rapid homogenisation (in less than two years) on the test sites was accompanied by an expansion of some beetle species including the forest species, *Pterostichus madidus*, who were 4 times more abundant in test site traps in 2012 compared to 2011.

Hoverfly, *Syrphus ribesii*. © FREDON

Micromammals

Of the 19 species of mammals that may be found in the region, 11 were inventoried, 9 of which as part of inventories protocols for a total of 80 individuals and 2 species identified within the framework of complementary inventories (the Dormouse, *Muscardinus avallanarius* and the European mole, *Talpa europaeus*). Three of the species caught are directly linked with agricultural crops: Vole (common vole or field mouse, *Microtus arvalis*), the European Pine Vole (*Microtus sub-*

terraneus) and the terrestrial vole (*Arvicola terrestris*). The proximity of woodlands further allowed mammals from nearby forest cover to operate among nearby crop cultures. This is particularly true of the Bank Vole (*Clethrionomys glareolus*) and the Wood Mouse (*Apodemus sylvaticus*). The presence of the Harvest Mouse (*Micromys minutus*) is more astonishing since this species is usually found in wetlands, making its nest among reed beds. Finally, few shrews were captured perhaps because they found the bait used to attract them less interesting.

Hedgehogs

European Hedgehogs (*Erinaceus europaeus*) move regularly across the site, between the woodlands and nearby urbanised areas. They regularly used the grassy strips as daytime resting areas but also for night hunting. Monitoring for this study suggested that the hedgehog may be more present in the area than previously thought. Unmarked individuals were regularly encountered during night surveys. The population could not be estimated.

CONCLUSION

Horticultural improvements, hedges and flowery strips impact the populations on the agricultural plain and meet diverse ecological functions.

Such improvements first represent an area of refuge for many species. Although the make-up of the earthworm and springtail communities are comparable from one medium to another, differences become apparent in the number of individuals found with a marked increase in samples collected among the flowering strips. Similar results were encountered with respect to hoverflies, ladybirds and lacewings.

The corollary of this observation is that these facilities provide a source for crop auxiliaries. Species forage into the field from these field amenities. Our study of the ground beetle populations showed that there is a rapid homogenisation among flowering strip communities and for at least the first thirty meters inside the field. This indicates that predatory species that are able to find refuge in the flowering strips can actually serve as crop auxiliaries up to a certain distance from liminal areas.

Such structural arrangements provide food resources for many species. Hoverflies seem especially attracted by the presence of flowers. The humidity and availability of organic material in these arrangements are favourable to earthworm and springtail communities. The presence of such fauna in the soil, allows the unfolding of essential functional processes for recycling the organic materials and the supply of mineral elements.

These structural elements also appear to play a role in establishing preferential corridors in orienting soil fauna but also for the hedgehog that plays an important role in controlling slug populations.

Finally, these elements also play a buffering role for certain populations of field mammals, some of which can cause extensive crop damage. Beyond the cyclical population changes, amenities attract predators and contribute to the stabilisation of their populations. Indeed, several predators including owls (*Tyto alba*), the kestrel (*Falco tinnunculus*) and the Long-eared owl (*Asio otus*) were seen repeatedly as they hunted among these elements.

The system is fully dynamic and interactions should increase, especially with the establishment of stands of agro-forest. It is recommended that the study process be maintained in order to develop more robust insights into the dynamics and long term effects of mixed land use strategies.

Indeed many questions remain unanswered: what are the most favourable syrphid species? How can we promote these? How are aphids impacted by parasiticoid wasps? What is to be recommended in terms of horticultural facilities and farming practices? In what ways do parcellary amenities such as hedges and flowering strips address the challenges of creating and promoting green and blue networks for the development and dispersion of crop auxiliaries in cultivated areas?

BIBLIOGRAPHY

BAUGNÉE, **J.-Y.**, **BRANQUART**, **E.**, 2000 - *Clef de terrain pour la reconnaissance des principales coccinelles de Wallonie (Chilocorinae, Coccinellinae et Epilachninae)*. Jeunes & Nature ASBL - Faculté Universitaire des Sciences Agronomiques de Gembloux, 43p. **BILLETER R.**, **LIIRA J.**, **BAILEY D.**, **BUGTER R.**, **ARENS P.**, ***et al.***, 2008 - Indicators for biodiversity in agricultural landscapes: a pan-european study. *Journal of Applied Ecology,* 45, 141-150. **Bouché M.-B.**, 1972 - *Lombriciens de France, écologie et systématique*. INRA Annales de Zoologie – Écologie animale. Publication, France, 671 p. **CLUZEAU D.**, **PÉRÈS G.**, **GUERNION M.**, **CHAUSSOD R.**, **CORTET J.**, **FARGETTE M.**, **MARTIN-LAURENT F.**, **MATEILLE T.**, **PERNIN C.**, **PONGE J.-F.**, **RUIZ-CAMACHO N.**, **VILLENAVE C.**, **ROUGÉ L.**, **MERCIER V.**, **BELLIDO A.**, **CANNAVACCIUOLO V.**, **PIRON D.**, **ARROUAYS D.**, **BOULONNE L.**, **JOLIVET C.**, **LAVELLE P.**, **VELASQUEZ E.**, **PLANTARD O.**, **WALTER C.**, **FOUCAUD-LEMERCIER B.**, **TICO S.**, **GITEAU J.-L.**, **BISPO A.** 2009 - Intégration de la biodiversité des sols dans les réseaux de surveillance de la qualité des sols : Exemple du programme-pilote à l'échelle régionale, le RMQS BioDiv. *Étude et Gestion des Sols,* 16, 187-201. **COULON J.**, **PUPIER R.**, **QUEINNEC E.**, **OLLIVIER E.**, **RICHOUX P.**, 2011a – Coléoptères carabiques : compléments et mise à jour. *Faune de France 94 (volume 1)*, 352 p. **COULON J.**, **PUPIER R.**, **QUEINNEC E.**, **OLLIVIER E.**, **RICHOUX P.**, 2011b – Coléoptères carabiques : compléments et mise à jour. *Faune de France 95 (volume 2)*, 337 p. **CURRY J.P.**, **BYRNE D.**, **SCHMIDT O.**, 2002 - Intensive cultivation can drastically reduce earthworm populations in arable land. *European Journal of Soil Biology*, 38, 127-130. **DALE**, **V.H.** & **POLASKY**, **S.**, 2007 - Measures of the effects of agriculture practices on ecosystem services. *Ecological Economics*, 64, 286-296. **DECAËNS T.**, **BUREAU F.**, **MARGERIE P.**, 2003 - Earthworm communities in a wet agricultural landscape of the Seine Valley (Upper Normandy, France). *Pedobiologia*, 47, 479-489. **DECAËNS T.**, **MARGERIE P.**, **AUBERT M.**, **Hedd, M.**, **BUREAU F.**, 2008 - Assembly rules within earthworm communities in North-Western France - A regional analysis. *Applied Soil Ecology*, 39, 321-335. **DE SNOO G.R.**, 1999 - Unsprayed field margins: effects on environment, biodiversity and agricultural practice. *Landscape and Urban Planning,* 46, 151-160. **DORIOZ J.-M.**, **WANG D.**, **POULENARD J.**, **Trévisan D.**, 2006 - The effect of grass buffer strips on phosphorus dynamics – A critical review and synthesis as a basis for application in agricultural landscapes in France. *Agriculture, Ecosystems and Environnement*, 117, 4-21. **HENDRIX P.F.**, **EDWARD C.A.**, 2004 - Earthworms in agroecosystems: research approaches. *Earthworm Ecology*. Ed. C.A. Edwards, 2nd edition, CRC Press, Boca Raton, London, New York, 287-295. **HOPKIN S.P.**, 2007 - A Key to the Springtails (Collembola) of Britain and Ireland. *Field Studies Council* (AIDGAP Project), 245 p. **INRA**, 1976 - Les bocages : histoire, écologie, économie. In : *Compte rendu de la table ronde CNRS Aspects physiques, biologiques et humains des ecosystems bocagers des régions tempérées humides*. INRA, CNRS-ENSA & Univ. Rennes, 5-7 juillet 1976, 586 p. **KRANTZ G.W.**, 1978 - *A manual of acarology, 2nde edition*. Oregon State University Book Stores, Inc. Corvallis, 509 p. **KROMP B.**, 1999 - Carabid beetles in sustainable agriculture : a review on pest control efficacy, cultivation impacts and enhancement. *Agriculture, Ecosystems and Environnement*, 74, 187-228. **LAGERLÖF J.**, **WALLIN H.**, 1993 - The abundance of arthropods along two field margins with different types of vegetation composition: an experimental study. *Agriculture, Ecosystems and Environnement*, 43, 141-154. **METZKE M.**, **POTTHOFF M.**, **QUINTERN M.**, **HESS J.**, **JOERGENSEN R.G.**, 2007 - Effect of reduced tillage systems on earthworm communities in a 6-year organic rotation. *European Journal of Soil Biology*, 43, 209-215. **PAOLETTI M.G.**, 1999 - The role of earthworms for assessment of sustainability and as bioindicators. *Agriculture, Ecosystems and Environment*, 74, 137-155. **PELOSI C.**, **PEY B.**, **HEDDE M.**, **CARO G.**, **CAPOWIEZ Y.**, **GUERNION M.**, **PEIGNÉ J.**, **PIRON D.**, **BERTRAND M.**, **CLUZEAU D.**, 2014 - Reducing tillage in cultivated fields increases earthworm functional diversity. *Applied Soil Ecology*, 83, 79-87. **PONGE J.-F.**, **DUBS F.**, **GILLET S.**, **SOUSA J.-P.**, **LAVELLE P.**, 2006 - Decreased biodiversity in soil springtail communities: the importance of dispersal and landuse history in heterogeneous landscapes. *Soil Biology & Biochemistry*, 38, 1158-1161. **SIMS R.W.**, **GERARD B.M.**, 1999. *Earthworms: notes for the identification of British species, 4th edition.* Published for the Linnean Society of London & the Estuarine & Coastal Sciences Association by Field Studies Council, Montford Bridge, Shrewsbury, 169 p. **SPEIGHT**, **M.C.D. & SARTHOU**, **J.-P.** (2011). *StN keys for the identification of adult European Syrphidae (Diptera)*, Glasgow 2011/*Clés StN pour la détermination des adultes des Syrphidae Européens (Diptères)*, Glasgow 2011. Syrph the Net, the database of European Syrphidae, Syrph the Net publications, Dublin, 66, 120 p. **SPEIGHT**, **M.C.D. & SARTHOU, J.-P.**, (2013). *StN keys for the identification of adult European Syrphidae (Diptera) 2013/ Clés StN pour la détermination des adultes des Syrphidae Européens (Diptères) 2013*. Syrph the Net, the database of European Syrphidae, Syrph the Net publications, Dublin, 74, 133p. **TSIOURIS S.E.**, **MAMOLOS A.P.**, **KALBURTJI K.L.**, **ALIFRAGIS D.**, 2002 - The quality of runoff water collected from a wheat field margin in Greece. *Agriculture, Ecosystems and Environnement* 89, 117-125. **ZABORSKI E.R.**, 2003 - Allylisothiocyanate: an alternative chemical expellant for sampling earthworms. *Applied Soil Ecology*, 22, 87-95.

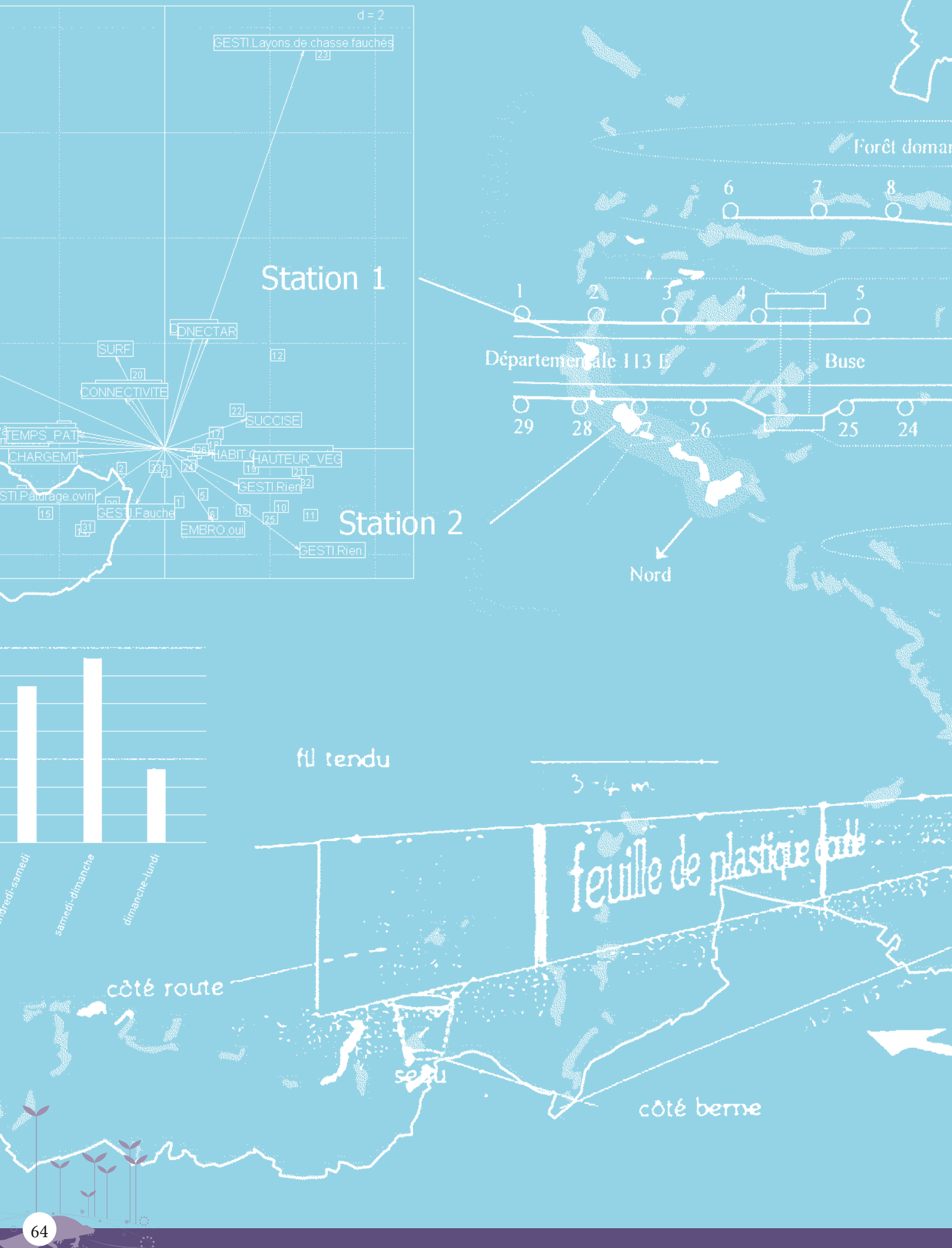
ACKNOWLEDGMENTS

Thanks to Marc Lefebvre who welcomed our research proposal, offered his property for experimentation and had the audacity to experiment with new techniques; thanks to other farmers whose lands adjoined our test plots, and allowed us to collect samples on their plots; Thanks to Virginie Dahinger, Martine Deguette, Audrey Coulon and Caroline Milleville of FREDON. Thanks to the Nord – Pas-de-Calais Regional Council for their assistance in this study and to Mr Canard, French lacewing specialist for his help in identifying collected lacewings. Thanks to Pierre Levisse, of the Caps et Marais d'Opale Natural Park, to Vincent Cohez and Simon Dutilleul from the Mammological coordination of the North of France, for their support in the course of this study.

FUNDING

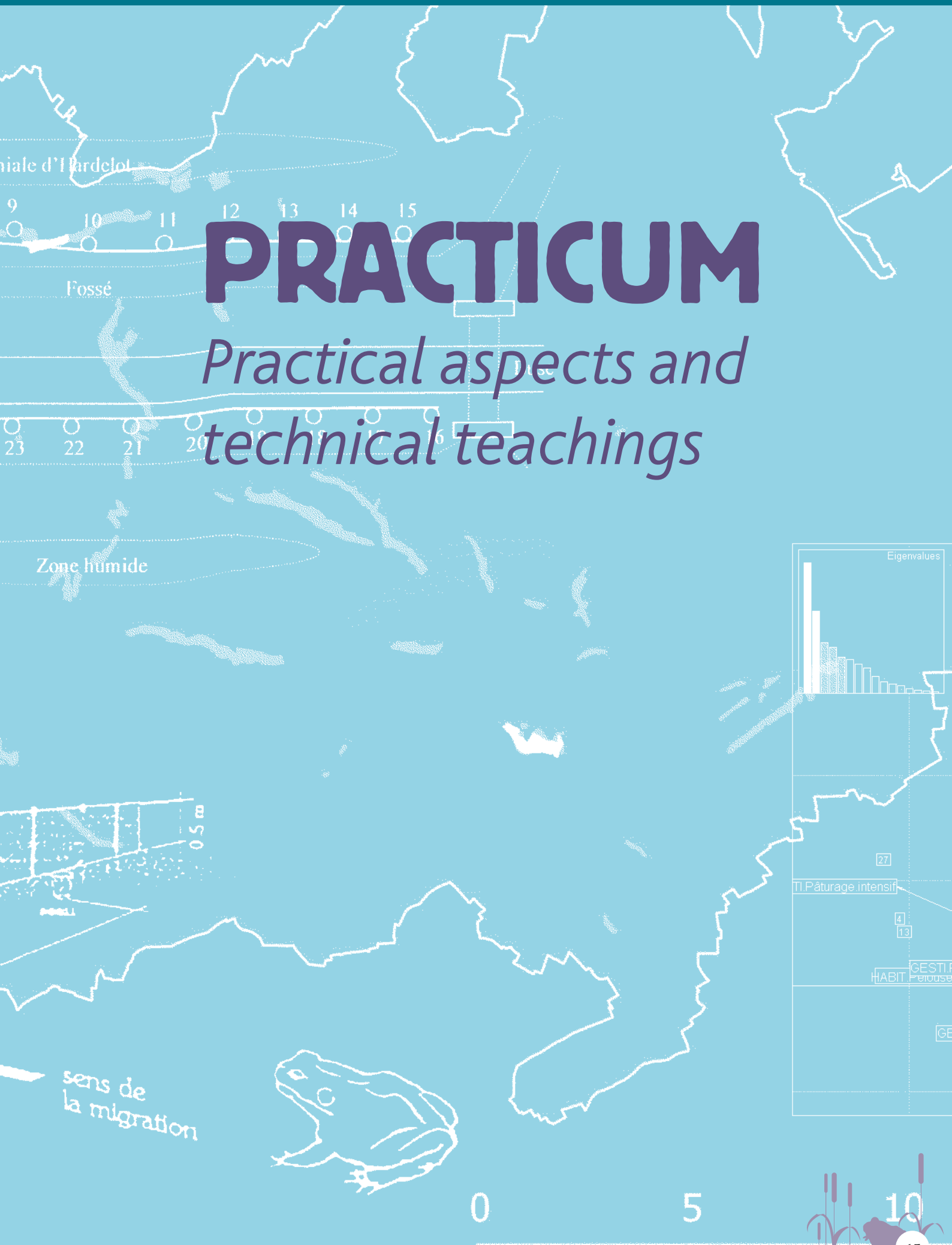
This study was conducted with financial support from the Nord – Pas-de-Calais Regional Council, and the Fondation pour la recherche sur la biodiversité for the Nord – Pas-de-Calais

Notes


d = 2
GESTI.Layons.de.chasse.fauchés
Station 1
DNECTAR
SURF
CONNECTIVITE
SUCCISE
TEMPS_PAT
CHARGEMT
HABIT
HAUTEUR_VEG
GESTI.Rien
STI.Pâturage.ovin
GESTI.Fauche
EMBRO.oui
Station 2
GESTI.Rien
Forêt doma
6
7
8
1
2
3
4
5
Départementale 113 D
Buse
29
28
26
25
24
Nord
fil tendu
3-4 m
feuille de plastique noir
côté route
côté berme
samedi-dimanche
dimanche-lundi

PRACTICUM

Practical aspects and technical teachings



The Fire Salamander (*Salamander salamander*).
M. Geniez/Biotope

Author: J. ROBILLIARD

Participate in the preservation of amphibians the example of the Condette amphibian barrier

INTRODUCTION

Roads and railways are the main causes of fragmentation of land and natural environments and they are obstacles to the movement of aquatic and terrestrial fauna. Besides the actual blockade effect, major infrastructures diminish and fragment the home range of species and cause an increase in mortality by collision. The territory of the Caps et Marais d'Opale Regional Natural Park has over 3130 linear km of roads and various projects have been completed or are under way to minimize these effects. One of the projects launched in the territory is the "rescue" of amphibians in Condette, as it was carried out at the dunes of the Slack on a larger scale (EDEN 62).

On the coastal part south of the Boulonnais, between the forests of Écault and Hardelot, the complex formed by the Claire Eau pond, the Lac des Miroirs and wetlands near the Château de Condette campsite is well-known for its rich flora and fauna. The site is eligible for listing under the European Habitats Directive.

Amphibians make several seasonal movements each year, to reach their hunting grounds, their wintering site or their breeding site.

It is virtually impossible to observe these animals when they are in their hunting territory or on their wintering site. They are more easily observable when on their egg-laying site but they don't remain there long enough to allow a comprehensive inventory of individuals. The migration window is therefore the only time to draw reliable conclusions from watching them, due to the concentration of their movement in time and space.

Common toads (*Bufo bufo*), Condette April 2009

CONTEXT

During the 1990s, a large number of amphibians were found crushed by motorists on the road between the Lac des Miroirs and the Claire Eau pond in Condette. A study was conducted by batrachologists at the request of the GDEAM (a local organisation for environmental protection) in 1997, since the area was believed to be a privileged migratory route. A temporary barrier was installed in late February 1997 consisting of 120 meters of tarpaulins suspended on a wire. The device was installed only on the west side of the road and was removed in early April. The set-up led to the capture of 194 individuals composed essentially of **Common Toads** (*Bufo bufo*) **Common frogs** (*Rana temporaria*), **Alpine newts** (*Ichthyosaura alpestris*) and **Palmate newts** (*Lissotriton helveticus*) and showed that the barrier was actually not positioned on the migration path but on a trajectory used by individuals moving between ponds. The installation of a permanent system therefore did not seem necessary at this location.

Following the GDEAM study, an area with a high mortality rate for amphibians was identified in the Natural Park in the same district, where 163 Common toads were found dead after only a single night of migration activity, the D113E roadway. As a result, a first barrier was installed on this county road in 1999 by the association "Les Écologistes du Boulonnais" (Boulonnais Environmentalists), in anticipation of siting the barrier at the most suitable position on the migratory route. While the devices have evolved over the years, records are still kept today. They are useful in assessing the devices in terms of results and identifying both the need to establish a permanent passage to facilitate the crossing of amphibians and defining the importance of such crossing in this sensitive area in order to restore the environmental framework in this strategic area.

Amphibian barrier in Condette. © PNR CMO

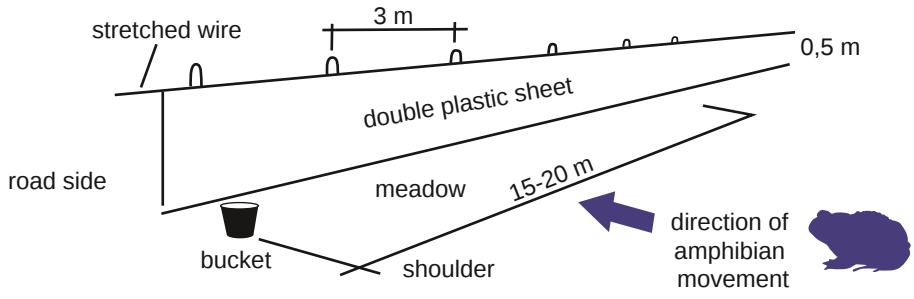
Methods based on constant adjustments

The migratory axis marked on the D113E is ideal to study the paths of amphibians. Indeed, the road cuts through the amphibians' wintering site (forest) and breeding site (ponds), and is a major cause of mortality for these animals every spring.

A system was installed to capture amphibians coming from the forest of Hardelot in spring and from the wetlands during the autumn migration. A 40-50 cm high plastic tarpaulin was installed, secured by small wooden stakes, covering about 150 meters on each side of the road.

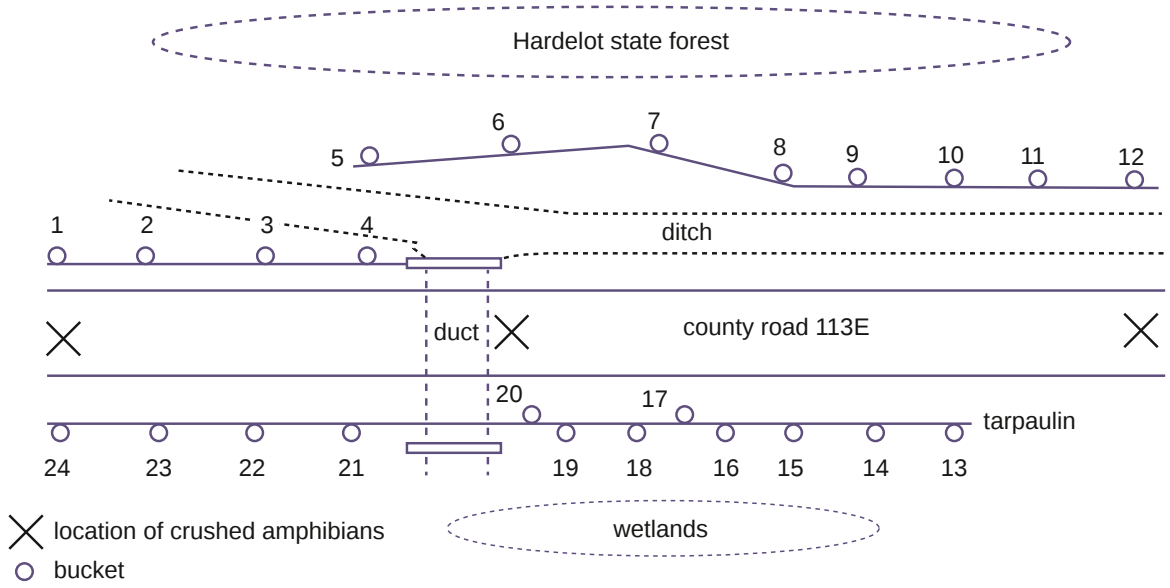
Such a cover is sufficient barrier to block migratory amphibians. Buckets were placed at ground level, every 15-20 meters along the tarpaulin to trap the animals. Indeed, they tend to walk along the obstacle and fall into buckets from which they cannot escape on their own. Since amphibians usually move at night and primarily between 8pm and 11pm, it is easy to come in the morning

Description of the set-up to capture amphibians



Modified device 1999

Placement of buckets



and count those captured in the buckets and release them on the other side of the road after recording relevant data.
Daily records were kept by volunteers, as well as agents of the ONF (National Forest Office) and the Park. Records are taken each morning.
A public awareness campaign was launched primarily to raise awareness among motorists. Indeed, the main road is a busy road. Information boards were installed on both sides of the road.
The device has evolved over the years, with some interruptions (2004-2007).

Above is the device used in 1999 when the barrier was first installed.
The first twelve buckets were placed on the forest side of the road. They were intended to capture amphibians during their migration from their wintering site to their breeding wetlands. The last twelve buckets were placed on the side of the wetlands. They were intended to capture the amphibians during their return migration. Special buckets 17 and 20 were placed on the inside of the road to drain excess water. They could, when necessary, capture amphibians that crossed the barrier passing between buckets 4 and 5.

In 2000 the operation continued. This time the installation was made up of 29 buckets distributed on either side of the road.

The Department Road Service supported the project by installing vehicle counters between February 29 and March 6 and again between March 20 and 29 in order to provide information on traffic on the D113E road. The average was about 2,900 vehicles per day including 5% heavy vehicles. Traffic between 8pm and 11pm was not at its heaviest. However, the number of vehicles passing through between 8pm and 1amwas much higher on weekends.
Different solutions were then discussed, such as the renewal of the barrier, a temporary closing of traffic on this section of the road between 8pm and 7am, creating alternative ponds or building an amphibian crossing.

The device could not be installed in 2001 and was set up again in 2002, this time by the ONF in partnership with the Park. In 2003, the device continued to be used

Smooth Newt (*Lissotriton vulgaris*). © A. Boulanger

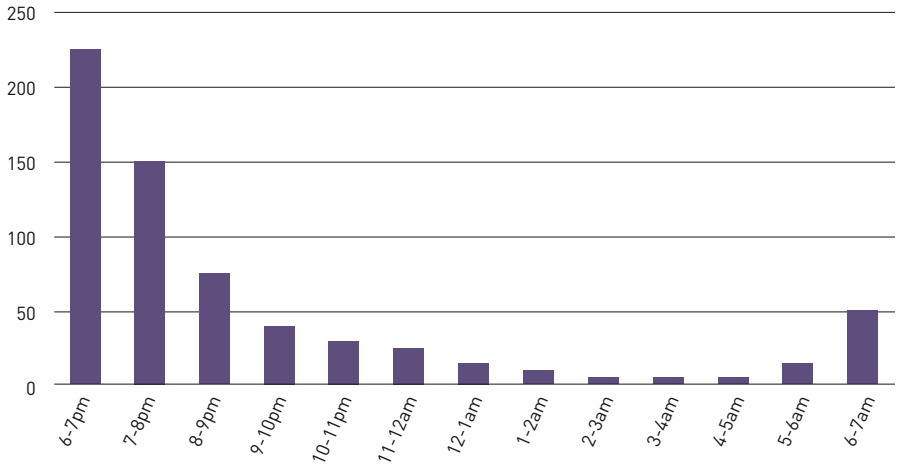
with the help of Coulogne high school students supervised by the Park and the ONF staff.

The device was then abandoned for a while to be resumed in 2007 with a similar device installed by the Park in partnership with the town of Condette. Substitution ponds were also created by the ONF.

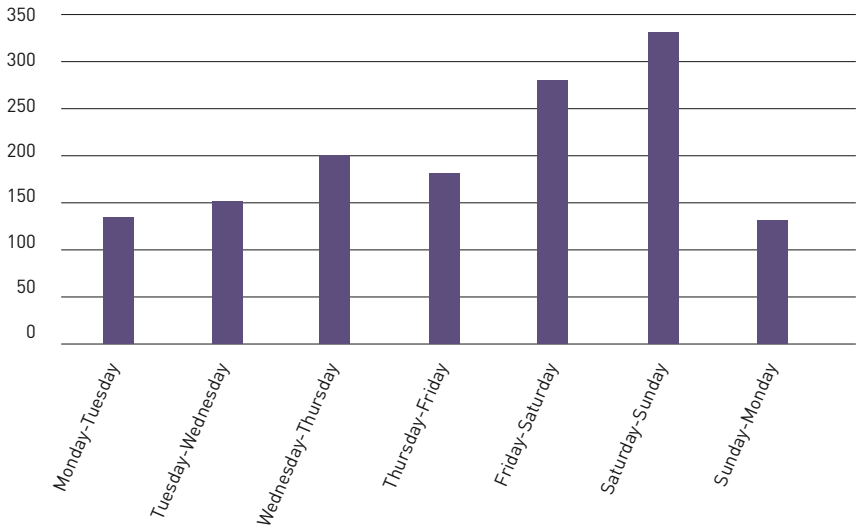
In 2006, a temporary road closing was tested where traffic was banned from 8pm to 7am. Several complaints were filed at city hall and some drivers moved the barriers and drove through the off-traffic section. This solution was thus abandoned.

Common Frog (*Rana temporaria*). © A. Boulanger

Starting in 2008, measuring rods were installed near existing ducts and water levels were monitored every week. The device was put back into place with a change in the tarpaulin positioning now extending on two 200-meter continuous lines along the road. This time 24 buckets were placed along the road, 12 on each side. This system has been kept up in the years that followed. It has been implemented by the Park in partnership with the municipality and the *Centre d'Animation Jeunesse* (CAJ - Youth Action Centre) of Saint-Étienne-au-Mont, town volunteers, the ONF, etc.



Number of vehicles travelling at night



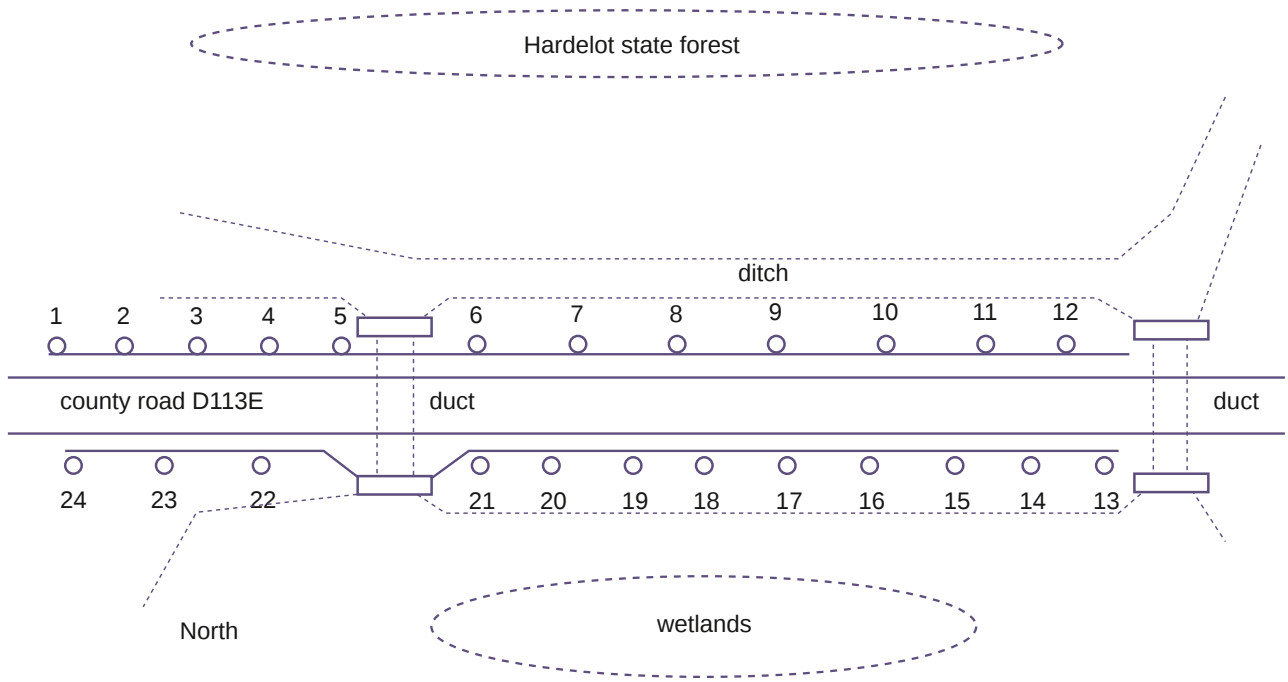
Number of vehicles between 8pm and 1am by day of the week

Concurrently with the installation of the device, the *Reine Rouge* association organized a participatory inventory of amphibians in the town of Condette including the amphibian barrier, the Condette marshes, the forest and ponds. Findings of this study confirmed the importance of monitoring and the amphibian barrier in this sector:

- In the town of Condette, 10 amphibian species were recorded, which shows how rich this particular area is. However, the territory remains fragile and continued efforts are necessary.
- We must continue to create breeding sites or manage other sites, and develop communication networks with private landowners and farmers,

Alpine Newt (*Ichthyosaura alpestris*). © M. Briola/Biotope

Amphibian barrier 2008-2015



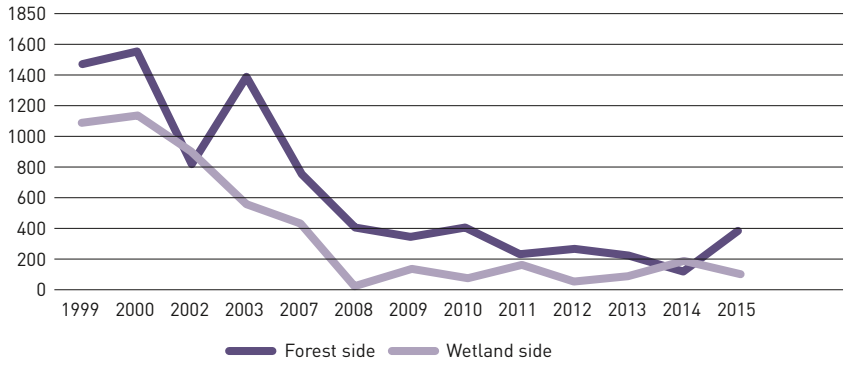
especially for populations of Great Crested Newts and European Tree Frogs.

RESULTS AND DISCUSSION

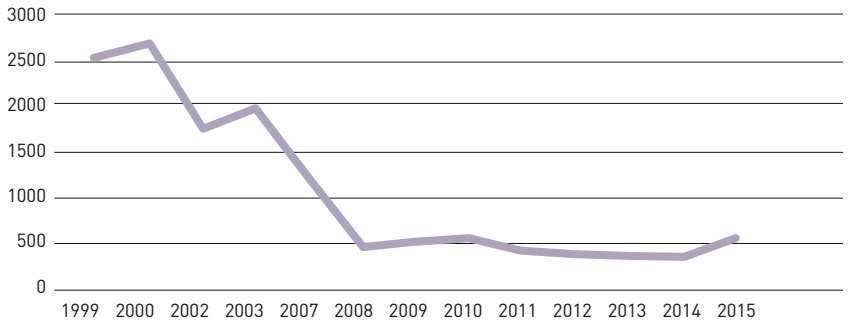
Change in number of individuals and devices

We noted a sharp decrease between the first installation of the device and 2015. Indeed, in 1999, more than 2,500 individuals were recorded while only 519 were tallied in 2015.

However, the curve of individuals captured on the forest side increased in 2015 for the first time in many years.



Number of migrating individuals captured along the barrier



Number of individuals between 1999 and 2015

The **Common Toad** (*Bufo bufo*) is largely dominant, - which makes sense given the type of natural environment - followed by the Alpine newt. In 2015, we noted an increase in the population of **Alpine newts** (*Ichthyosaura alpestris*) and **Palmate newts** (*Lissotriton helveticus*) fairly important compared to preceding years.

Few Brown Frogs pass through. The **Smooth Newt** (*Lissotriton vulgaris*) and the **Fire Salamander** (*Salamandra salamandra*) are not shown in the diagrams because their number has been very low each year.

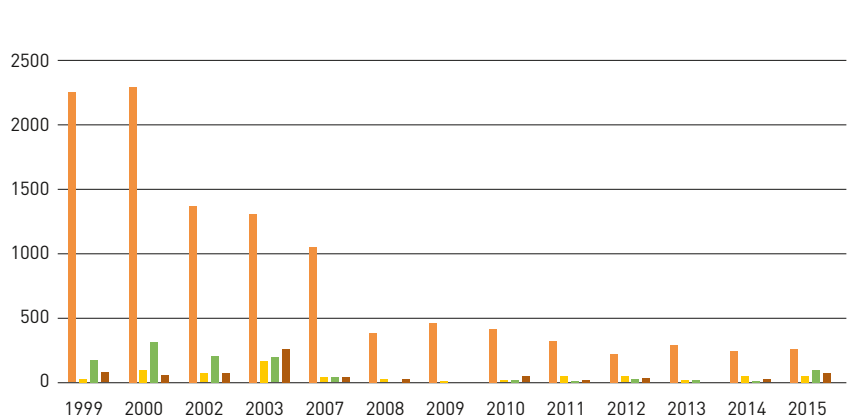
Change in the number of individuals crushed and dispositions

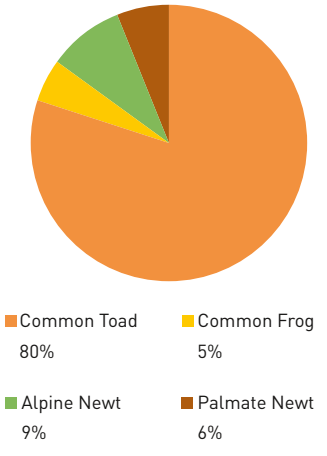
The number of individuals run over by motor vehicles declined sharply since 1999 (see diagram p. 72). Indeed, many devices have been tested and the last device installed (2008) has proven to be quite efficient. Since the total number of individuals decreased sharply, the resulting number logically, also decreased. The new disposition however has allowed total deaths to automobiles to fewer than five individuals.

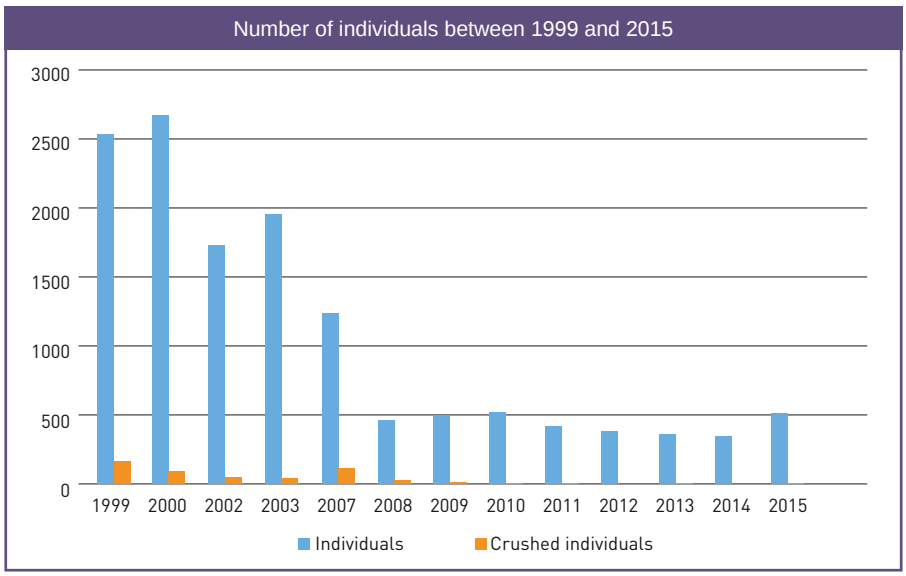
Discussion and outlook

The outcome of the work completed shows the effectiveness of the last device installed in terms of individuals crushed but several issues remain to be addressed especially in terms of future orientations.

Evolution of species between 1999 and 2015







Common Toads (*Bufo bufo*), Condette April 2009. © PNR CMO

Regarding the significant drop in the number of individuals identified over the years, several questions arise: is the area' s amphibian population in decline? Were the ponds created in 2007 useful to the toads - whose numbers decreased from more than 1000 individuals in 2007 to fewer than 500 in 2008 - to be able to reproduce when they had just been completed?

At present, Park managers have no definite idea as to where the breeding site of different individuals is: indeed, egg-laying in the nearby wetlands is rather insignificant. The most likely assumption would be that reproduction has moved to the Lac des Miroirs. In that case however, migrating individuals would have had to pass through the "rue nouvelle"; yet there have been no documented occurrences of road kill.

What lasting solution could be envisaged to maintain populations? The barrier device was not intended as a permanent scheme, and while the device was in place for over 15 years, the difficulty of maintaining the barrier and the temporary nature of the barrier which over time tended to reinforce a specific migration path, requires thought on what some form of alternative.

During the year 2007, a consulting firm was hired to study the possibility of installing amphibian tunnels along the main road and to provide technical expertise and costing figures to the Pas-de-Calais Department Council. The study revealed the presence of a water table at surface and near surface. Three ducts were found as well, including two that were heavily silted designed to permit water flow into the wetlands. To be functional an amphibian pathway not being must not be flooded. Speedbumps a possibility (the RD113E is ranked 1st class motorway), this would require two-way tunnels with some form of

Fire Salamander (*Salamandra salamandra*). © PNR CMO

vertical barrier, at any rate, a device better suited to the site (the study proposed five 12-meter long tunnels) and raising the road profile to between 20 and 30 cm, greatly increasing the cost of the procedure to benefit, in the end, a reduced number of individuals. Another solution may be to create several ponds upstream to limit the number of animals passing through the road, or even the possibility of forced breeding for a number of years to dissuade species from crossing the road if the building of an amphibian pathway is impossible.

CONCLUSION

This study contributed to the development of a barrier device for amphibians, improving the efficiency in this particular area over the years through collaboration between the Regional Natural Park, the town of Condette and the ONF assisted by many local associations and service managers.

A total of 80 people participated in this project and became aware of the importance of ecological corridors ("blue-green infrastructure") to ensure the survival and reproductive cycle of amphibians. Drivers using the RD113 also understood the impact of road infrastructure on the ecological framework over the years. This "rescue" operation now raises issues about the possibility of building amphibian crossings (and possible counting), and / or development work on wetlands to promote the reproductive cycle of amphibians without causing an impact.

While linear infrastructures are an obstacle to deployment of "blue-green infrastructures", they can also provide opportunities. Thus, a collaborative project with field managers is underway to develop differentiated roadside management, the construction of crosslinks (different wildlife passages have been installed and a study is underway for highway A16) and the use of abandoned places such as many chalky embankments, as potential heritage natural habitats.

Authors: L. BARBIER, A. MILLOT

The Creeping primrose (*Ludwigia peploides*).
A. Chapuis/Biotope

Primrose-willow

Nutria

Wels Catfish

Getting to know **exotic and invasive species**

INTRODUCTION AND DEFINITION

"Invasive alien species are recognized as one of the main causes of erosion of global biodiversity" (S. Moncorps and P. Dupont, 2015). It is difficult to generate interest on this topic especially when few people in the PNR are concerned by the issue of invasive species and because the means to set up in order to rectify invasive species induced disorders are enormous. Several examples of invasive species are presented below and will allow the reader to comprehend and frame the issue. It should be remembered however that avoidance remains the best solution. Generally, we should be careful when introducing a non-native species because one generally does not know about species adaptability or invasiveness.

We often speak of Exotic Invasive Species (EIS) that, once introduced whether by intention or by accident, threaten ecosystems, natural habitats or native species with negative consequences for the ecosystem or for socio-economic services and health (IUCN, 2000; Pysek et al, 2009; Genovesi and Shine, 2011; European Parliament and Council of Europe 2013 - in Sarat 2015 E. et al.***).***

CONTEXT

The Caps & Marais d'Opale territory deals regularly with alien species, whether from gardening centres or pet shops specializing in exotic plant and animal species (Nuttall's waterweed, *Elodea nuttallii*; Parrot Feather, *Myriophyllum aquaticum*); Red-eared Slider, *Trachemys scripta elegans*); Balsam, *Impatiens* sp.; Butterfly Bush (*Buddleja* sp.) but also from private individuals who voluntarily or involuntarily introduce new species for ornamental or economic use (e.g., the ornamental Floating Primrose, *Ludwigia* sp.), the Muskrat, *Ondatra zibethicus*, the American Bull Frog, *Rana catesbeiana* or the Wels Catfish (*Silurus glanis*). Other species may have come to Europe as hitchhikers on ocean-going cargo vessels such as the Chinese Mitten Crab or the Zebra mussel.

Many of these species are today integral components of our natural and urbanized areas. For some, continued development may be detrimental to local species or human activities. Others (the Muskrat for example) are responsible for significant crop damage and eradication programmes often prove costly.

The actions carried out on 5 species

Some species have been present in the Park for several decades, others arrived only recently. The Park's efforts with respect to five species in the Audomarois marsh are reported below.

1) The Muskrat (*Ondatra zibethicus*)

A species native to North America, the Muskrat was introduced to Europe early in the 20th century, around 1910 at the request of the fur industry. The animal measures between 50 and 60 cm including a 20 cm long tail. A mature muskrat can weigh up to 1.5 kilograms.

The Muskrat arrived in the Audomarois marshes in the 1950s. Its presence was revealed by unaccustomed animal foraging activity leading to damage to marsh banks and vegetable crops. In 1955, an association was incorporated to limit the proliferation of the muskrat. The association acted to control muskrat populations using traps and poisoned bait. In 2003, with the discontinuation of the use of poisoned bait, a Group for Defense against Pests (GDON) was established. Thanks to the mobilisation of all local players, a company of two professional trappers was created at that time. At the same time, the Park, the Saint-Omer urban community, the GDON along with the inter-communal syndicate for the management of the Aa River (SmageAa) and the Pas-de-Calais Federation of Hunters organized several trapper training sessions including mandatory training for the use of certain types of traps. In the end, more than 250 trappers were trained in the Audomarois district. To complete the training, public grants subsidized the purchase of traps (2500 units in 10 years). To support this programme the Park host intended as a forum for the sharing of experience and the collection of feedback.

The organisation of the struggle in the territories is essential for several reasons:

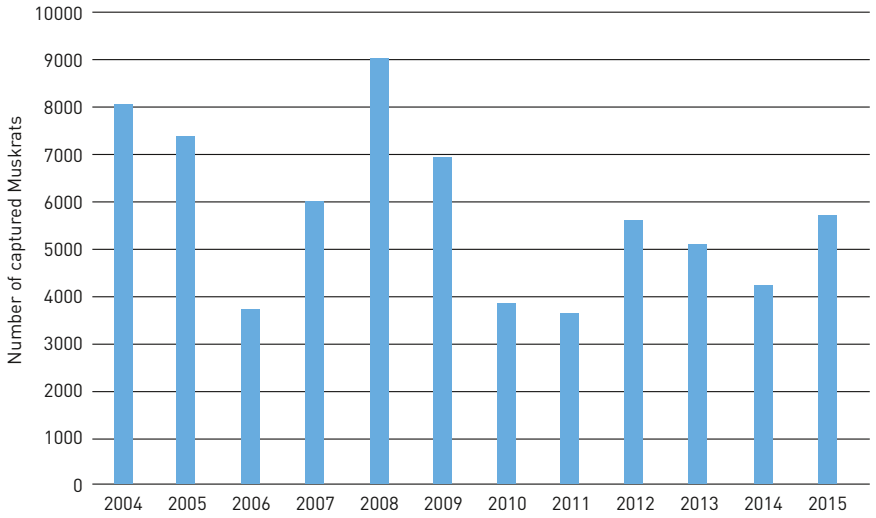
First, failure to resist would have been catastrophic for the marsh leading to significant crop damage, and the collapse of embankments with associated risks for both people and structures;

Secondly, it was a necessary element in any comprehensive programme to control pest populations;

Finally, a regulated trapping programme with a semi-annual assessment was the

Damage in a cabbage patch. © A. Millot

A rat trap. © A. Millot



Changes in the number of captured specimen from the Audomarois marshes since 2004 (GDON volunteers and professionals)

only way to continuously monitor efforts to eradicate the invasive species. On two separate occasions, in early July and early December, trappers are invited to turn in severed tails. More than a social occasion for the trappers, these assemblies have proven to be reliable indicators of the state of the muskrat population.

To get an idea of the potential impact of this rodent population, one has only to refer to the catch assessments which report between 3500 and 9000 animals captured annually over a ten-year period (2004-2014). See table below.

2) The Brazilian "feather plant" (*Myriophyllum aquaticum*)

This aquatic plant native to South America was introduced to France in 1880 in the Bordelais region. The plant has a long gnarled stem 3 to 4 m long and roots in marsh substrates.

The Parrot Feather (*Myriophyllum aquaticum*). © Biotope

The *Myriophyllum aquaticum* was discovered on the marsh in 2003 during a survey conducted by the Bailleul National Botanical Conservatory. Identified as an imminent threat to marsh ecology, the Botanical Conservatory immediately informed the Park.

In late autumn 2003, the technical team of the Park conducted a thorough uprooting of the whole station (one hundred 100-liter garbage bags). Meanwhile, the ditch which contained the plant source in the wild was isolated by a mesh to limit the dispersal of cuttings. The winter that followed was quite cold with a few nights at -10°C with the result that the weed never reappeared.

The origin of this infestation could have been deliberate and motivated by aesthetic reasons (the plant is very beautiful) or simply as an ejection by an aquarium hobbyist who may not have appreciated the risks associated with the introduction of this plant.

3) The Giant Hogweed (*Heracleum mantegazzianum*)

A land plant from the Caucasus, Hogweed made its way to Western Europe in the nineteenth century and has been considered "invasive" since 1950. This is a perennial herb which grows quite tall (from 2 to 5 m) and has stems of between ranging from 5 to 10 cm in diameter.

The Giant hogweed has often been planted for ornamental purposes. Its imposing flowers produce a lot of fruit that are disseminated. On the marsh, it was located at multiple stations, including one where its presence had come to dominant the local flora.

The Park intervened alongside the association EDEN 62 beginning in 2012 in an attempt to eradicate these populations

Muskrats captures between 2004 and 2014

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Trappers in the CASO	1949	2644	1432	1541	1863	1473	1382	2058	1776	1165
Departmental trappers	NR	245	NR	NR	0	0	0	0	-	-
Tail counts	5929	4440	2393	4439	6890	5417	2144	3334	3182	2893
(of which captures from the "iron fist" round-up)	-	-	-	-	-	-	-	-	[1145]	[549]
Trappers in Saint-Omer	-	-	-	-	154	73	110	126	227	114
Protocole Romelaere ponds	78	45	31	24	50	23	16	-	-	-
EDEN 62	-	-	-	-	-	-	-	58	106	51
TOTAL	**7956**	**7374**	**3856**	**6004**	**8957**	**6986**	**3652**	**5576**	**5291**	**4223**

Giant hogweed (*Heracleum mantegazzianum*). © A. Millot

and limit their extension, but also to limit potential impact on humans (contact with human skin can cause severe blistering, dermatitis and allergic reactions due ton chemicals contained in the plant). The operations carried out on the plant consisted essentially in repeatedly mowing the plant to exhaust the foot and prevent flowering and seed production. Incidentally, it appeared that sheep grazing in the spring was also very effective in limiting plant growth.

4) The Nuttall's waterweed (*Elodea nuttallii*)

The Nuttall's waterweed is native to North America as is its close cousin, the Canadian waterweed. It was introduced into Europe beginning in the 1950s. It is an aquatic plant that grows mainly by cuttings.

The Nuttall's waterweed was found among the marsh ponds of Malhove and Beauséjour in the Arques municipality in the course of work on the ecological management of the water bodies. These had in fact been covered with aquatic vegetation that was choking off normal aquatic activities. The control technique adopted was to mechanically cut all surface and underwater weeds in 2009. At the time, between 500 and 1000 tonnes of fresh organic materials were removed from the water bodies and the amount of materials appears to diminish every year. Currently two weed cuts are performed annually, the first in June, the second in

Wetlands mechanical mowing. © A. Poulain

Nuttall's waterweed (*Elodea nuttallii*). © A. Poulain

September. Under the project management arrangement, work is carried out by the city of Arques with participation from the 7th district of Wateringues.

Vigilance has proven to be important in these operations and various programmes have been tested to raise awareness among participants to limit plant colonisation from the rest of the marsh. It appears however that stations have been discovered in different parts of the marsh.

5) The Eastern crayfish (*Orconectes limosus*)

This is the first crayfish introduced in France around 1880. It has a maximum size of 11 cm. Its introduction has certainly contributed to the disappearance of indigenous species of crayfish among the Audomarois marshes and other Park wetlands.

Crayfish were sought on the marsh in 2013 and 2014 as part of a first campaign for capture. Standard crayfish basket traps were laid and baited. The bad news was that the American crayfish is omnipresent on the marsh; the good news was the absence noted at the time of the Louisiana Crayfish, or *Procambarus clarkii.*

The non-native crayfish are likely to create substantial disorder in the biological imbalances because they feed on plants, amphibian spawn and fish larvae. In some cases, they are likely to dig deep galleries that generate water management problems.

Other species, including species anticipated with dread

Among all other species present or suspected but which do not seem to cause substantial damage to existing wildlife

Lousiana Crayfish *(Procambarus clarkii).* © B. Adam/Biotope

Eastern crayfish *(Orconectes limosus).* © B. Adam/Biotope

and habitats, we can mention:

- **The Red-eared Slider (*Trachemys scripta elegans*)**. This turtle was sold in pet shops until 1997. Adults are omnivorous and can weigh 3 kg and more. The species live up to 30 years. In 2014 a nest was observed and destroyed.
- **The Chinese Mitten Crab (*Eriocheir sinensis*)**. It seems the species has been observed in the Audomarois marsh since at least the Second World War but has been recorded in Europe since the twentieth century. Also known as the Shanghai Hairy Crab, the Mitten Crab is a burrowing species, burrowing deep into marsh and river embankments. The Mitten Crab is one of only a few species of crab that will adapt to fresh or salt water even though it will only reproduce in a marine or highly brackish environment. Its impact is unknown and its distribution seems very limited.

Pond Slider, or Red-eared Slider *(Trachemys scripta)*. © M. Briola/Biotope

- **The Zebra Mussel (*Dreissena polymorpha*)**. Originally from the Black and Caspian seas, it almost certainly arrived in Europe attached to the hulls of ships or transported in ballast water. The presence of the Zebra Mussel in Europe has been documented since 1770.
- **Balsam (*Impatiens* sp.)**. These plants native to South Asia and the Himalayas, were introduced in the nineteenth and twentieth centuries as ornamental garden plants. They escaped from gardens to colonize many rivers banks where they cause the regression of the local flora.
- **Asian knotweed (*Reynoutria* sp.)**.

Impatiens balfouri. © Biotope

Native to East Asia and Japan, introduced in the nineteenth century as ornamental plants. They colonize many river banks where they compete with local species.

- **The Canadian Goldenrod and the Giant goldenrod (*Solidago* sp.)**. These plants were introduced as ornamental plants in the eighteenth century from North America. They, "escaped" from gardens and have become widespread in meadows and tall grasses where they compete with local species.
- **The Egyptian Goose (*Alopochen aegyptiaca*)**. Whether voluntary or involuntary, repeated introductions in several European countries have led to the relatively recent installation of Egyptian geese populations. It seems that from end of the 1980s, its population exploded, thanks to successive mild winters. Several pairs now breed regularly on the marsh.
- **The Wels catfish (*Silurus glanis*)**. Native to Central Europe the Wels catfish was introduced into France in the second half of the nineteenth century. This species arrived in the Nord – Pas-de-Calais region sometime in the first decade of the twenty-first century certainly as an intentional introduction for fisheries purposes. In the marshland, it was formally identified in the summer of 2013. Since then, the species has appeared more and more frequently with recorded individual weights of 5 to 6 kilograms. It is unknown what the consequences may be for the introduction of a large predator into the marsh ecosystem, especially given the difficulty in measuring the changes it might bring upon the endogenous fish fauna of the marsh.

Most species come to us via pet shops and garden centres. Some of them adapt very well and escape from gardens, plantings and local aquariums to compete directly with the endemic flora and fauna thus creating more or less predictable disorders that are not always visible. Such invasive species are a source of concern for existing ecological balances within the territory.

Silurus glanis. © B. Adam/Biotope

Two species are of particular concern today, mainly because they have already been spotted in the Artois-Picardie ba-

sin but also because they are known for their important environmental impacts. The Primrose-willows have already been detected less than 20 km from the Audomarois marsh while the Nutria has been spotted in the south of the neighbouring Nord Department. Particular vigilance has been called for among local actors in order to better anticipate the arrival of these species, including publication of a poster and an identification key. Such preventive outreach will almost certainly prove cheaper than management or eradication once these species become established in the marsh.

Primrose-willows (*Ludwigia* sp.), native to South America, were introduced in Languedoc around 1830 as ornamental plants. It must be put high on the list of

Jussiaea grandiflora. © M. Briola/Biotope

metropolitan invasive species. Significant resources have already been committed to eradication and management for already colonised territories, hence the need for vigilance before it arrives in the marsh.

- **The Nutria (*Myocastor coypus*)** is a rodent native to South American wetlands. The species was introduced to France in the nineteenth century. The adult weighs as much as 10 kg. It is a strict herbivore, consuming aquatic and terrestrial plants and it burrows. It is feared for the damage it may cause to crops and riverbanks.

CONCLUSION

The matter of invasive alien species worries many managers of natural and rural areas. For example, the cost of the fight against the muskrat in the Audomarois marsh today represents no less than the equivalent of three full-time salaried positions. And the Muskrat is not under control despite the efforts of a hundred, motivated volunteer trappers. Public awareness and community involvement need to be strengthened. The Regional Park has clearly communicated its desire to hear from residents with the slightest suspicion of new plants or species. Popularisation tools have been developed for this purpose.

Public awareness must also extend to companies working in wetlands so they too can exercise vigilance in maintenance of their machinery. If, after mechanically mowing a lake infested with Primrose-willows, Nuttall's waterweed or Brazilian Parrot Feather, a gardening contractor were to begin work on another site without cleaning the machinery, there are very good chances that further infestations will develop from very small cuttings.

The fight against invasive species should be everyone's concern. The means already engaged in fighting such infestations are considerable. Prevention implies working upstream from the infestation, through education and public awareness programmes, but also by cultivating balanced ecosystems and functional adaptive corridors able to avoid such invasive activity.

Finally, climate change is another cause for concern; increased average temperatures and the absence of a hard freeze over the winter months create conditions that stimulate the development of species that otherwise might have remained dormant. The solution then, is to modify one's behaviour.

BIBLIOGRAPHY

BENMERGUI M., **BULLIFFON F.** & **FOUQUE C.** 2011. *L'Ouette d'Égypte* Alopochen aegyptiaca : synthèse bibliographique et perspectives de gestion pour la France. Rapp. Int. ONCFS. 42 p. **SARAT E.**, **MAZAUBERT E.**, **DUTARTRE A.**, **POULET N.**, **SOUBEYRAN Y.**, 2015. *Les espèces exotiques envahissantes. Connaissances pratiques et expériences de gestion*. Volume 1 – connaissances pratiques. ONEMA. 252 pages. **CENTRE RÉGIONAL DE PHYTOSOCIOLOGIE/CONSERVATOIRE BOTANIQUE NATIONAL DE BAILLEUL**, 2012-2013. Inventaire des habitats naturels et de la flore aquatique des rivières wateringues du Marais Audomarois. **MILLOT A.**, 2013. Inventaire des écrevisses du marais audomarois. Parc naturel régional des Caps et marais d'Opale. 21p. **MILLOT A.**, 2014. Synthèse naturaliste du marais audomarois 2014. Parc naturel régional des Caps et Marais d'Opale. 31p.

Conclusion

The results presented in this work show the diversity of approaches used in responding to problems of biodiversity posed by public actors across a territory. This work really only represents a progress report for projects which are both technically specific and scientific and contribute to understanding and dealing with global issues, and naturalistic, community based projects that address community and territorial issues.

Species monitoring and knowledge of species behaviour on the territory involved both iconic protected species and groups, even less familiar kingdoms and phyla.
Some studies presented here such as the "agricobio" project demonstrate that it is possible with partner support to organize robust studies with specific protocols in actual park working conditions. Indeed, it is sometimes necessary to build a strong case that cuts across disciplinary fields to build real understanding and support for policies that promote biodiversity. Other studies show that it is possible to achieve results through the mobilisation of technical teams, individual naturalists or even entire communities.

This knowledge is useful for several reasons. It allows us to use the monitoring results both as bioindicators, for instance in studying climate change, or as connectivity vectors in studying blue and green networks. It also contributes to conservation management while informing appropriate economic policies and investment in infrastructure for biodiversity conservation.

More than merely offering a recital of a territory's remarkable ecology whether for entomological, fungal or avian fauna, studies show that such interpretations are complex and sometimes even antagonistic when it comes to favouring this or that particular species of fauna, flora or fungi in the management of nature reserve spaces. All however, illustrate the importance of maintaining and developing mosaics of habitats and functional habitats networks for regaining and maintaining species.

Many cases have shown the importance of the naturalists contributions but also of the mobilisation of volunteers in leading practical actions. Most of the articles refer to international exchanges, especially with England and Belgium, as much in terms of methods as results; in fact, sharing programmes is essential as demonstrated by the success of the Channel/North Sea bird watching effort. The training effort required to cultivate community involvement of a territory must continue and in so doing contribute to and nurture the scientific and naturalistic data bases. Today the Park's biodiversity observatory compiles all naturalist contributions for more than 220 species. This tool allows Park actors and stakeholders to track local conditions and respond locally, regionally and globally.

It is understood that the Park should continue its scientific and naturalistic studies with respect to Park territory. These can only be achieved cooperatively, in partnership with public managers, naturalists, universities and local communities with a view to strengthening the exploration effort, exchanging information and taking action.

Glossary

Anecic: In zoology, an anecic worm is a worm that lives in the soil and feeds on dead leaves. One of the three categories of earthworms: epigeic, endogeic and anecic.

Aphidiphagous: In zoology, an organism that feeds on aphids as is the case of most hoverflies of the family Syrphidae.

Coprophilous: Organisms (mainly bacteria) living in fecal matter.

Detritiphagous: Organisms that feed on carrion and fecal matter. Thus includes mammals, birds, insects, as well as fungi and bacteria.

Diapause: A pause or phase in the growth and development of an organism due to adverse environmental conditions.

Elaiosome: A fleshy structure attached to the seeds of some plant species.

Endogeic/epigeic: a species or community of species is said to be endogeic (or hypogeic in botany) if it lives into the soil (as opposed to "epigeic" refering to species germinating or living on the surface).

Ground beetle: Coleoptera of the Carabidae family with metallic reflections, feeds on insects and their larvae.

Heliophilous: that thrives in full sun.

Hemiedaphic: means living in the superficial soil layers and leaf litter.

Hover fly: Dipteran insects with short antennae (like flies), a black and yellow abdomen, quickly flying.

Imago: An insect in its sexually mature, adult stage following complete or incomplete metamorphosis.

Mesofauna: A category of the fauna whose size is comprised between that of the microfauna and that of the macrofauna. The mesofauna includes the small animals whose size ranges from 0.2 to 4 mm living within a particular area.

Metapopulation: Ecological concept defining a group of spatially or temporaly separated populations of the same species which interact at some level. These populations live on patches of habitat of varying quality within the metapopulation and at any time, some patches could be available and unoccupied.

Mycetophagous: Said of an insect or organism that feeds on fungi that either it cultivates (as do some ants and termites) or on which it preys (dipterans).

Ovipositor: In entomology, an abdominal appendage, usually long and tapered, with which many female insects (especially parasitic wasps) lay their eggs in places most favorable to their incubation. This organ is also often used to pierce plants, the soil or other insects larvae.

Parasitoid: Organism that develops on or within another organism called the "host", which it invariably kills during or at the end of this development, whereas most parasites do not kill their host.

Phenology: Study of variations, depending on the climate, of periodic phenomena of plant and animal life.

Saprophagous: That feeds on rotten and decaying matter.

Sporophore: the "fruiting body" of mycelium fungi, e.g. a mushroom.

Ubiquitous: in ecology, represents the ability of a living organism to adapt to multiple habitats.

Principal Sources (among many): Dictionnaire de l'agriculture et de la vie rurale (Larousse Thématique), Encyclopaedia Universalis (universalis.fr), Petit Robert 1, larousse.fr, Wikipédia.org, Wiktionary (https://en.wiktionary.org/), Wikipedia (https://en.wikipedia.org), Collins Dictionary (http://www.collinsdictionary.com/), the Free Dictionary (http://www.thefreedictionary.com/), Environment and Climate Change Canada (https://ec.gc.ca/faunescience-wildlifescience)

List of Acronyms

CASO: Urban Community of Saint-Omer
CEN: Conservatory of natural spaces or Nature conservance
CHEG:
C - *Clavariacae*,
H - *Hygrocybe*,
E - *Entoloma*,
G - *Geoglossaceae* (a sporophore group defined by British mycologists)
CMO: Caps and Marais d'Opale
COB: Cape Ornis Banding
CSENPC: Scientific and Environmental Council for the Nord – Pas-de-Calais
IAS: Invasive alien species
ERDF: European Fund for Regional Economic Development
FREDON: Regional Federation of defence against pests
GDEAM: Environmental Defence Group in the borough of Montreuil-sur-Mer
GDON: Grouping for defence against pests
GON: North France Ornithological Group
INRA: National Institute for Agronomic Research
IUCN: International Union for the Conservation of Nature
LPO: League for the Protection of Birds
ONF: National Forestry Office
OPIE: Office for eco-entomological information
PNR: Regional Natural Park sometime abbreviated RNP
RNR: Regional Nature Reserve
SMNF: Mycological Society of Northern France
SRCE: Regional Masterplan for Ecological Coherence

Contact

Parc naturel régional des Caps et Marais d'Opale

Welcome Centres:
Manoir du Huisbois, Le Wast
Maison du marais, Saint-Martin-au-Laërt

Postal address: BP22, F-62142 LE WAST

Tel.: +33 (0)3 21 87 90 90
e-mail: info@parc-opale.fr
www.parc-opale.fr

Publisher: Parc Naturel Régional des Caps et Marais d'Opale
Publications director: Dominique REMBOTTE
Coordination: Caroline DELELIS - Alexandre POULAIN
Layout: Biotope

This magazine is translated from French, despite a careful proofreading, some typos may remain, we apologize for that.

Acknowledgements

- With a special thanks to all volunteer observers and non-profit organizations who contributed to ongoing Park inventories and bird watching events. For many companions, the community effort goes back to our very beginnings in 2005. Thank-you.

ANSEL Sébastien, AUCOIN Alison, AVET Coralie, BAFCOP Roland, BARBIER Luc, BARBIN Orelia, BARROUX Francis, BECQUART Remy, BÉDAGUE Patrick, BEESE Christian, BEHAGUE Pablo, BERNARD Catherine, BERTELOOT Jacques, BIECQUE Aurélien, BIENAIMÉ Éric, BIGOT Benjamin, BOILEAU Nicolas, BOIN Sébastien, BONNEFOY Adrien, BOSQUERT Samuel, BOSQUET Jérôme, BOUIN Charlotte, BOULANGER Arnaud, BOUREL J.-Y., BOUTIN Mathieu, BRABANT Hubert, BREFORT Annick, BUSSON Julie, CAINNE Paul, CALONNES Pierre, CANNESSON Philippe, CAPON Yves, CASTELAIN Antoine, CENIER Audrey, CEUGNIEZ Xavier, CHAÏB François, CHALLAMEL Marie-Laure, CHESTERMAN Danny, CLAIRET Carole, CLIPET Jean-Pierre, COANON Anne, COLLART Paul, CORDELA Philippe, COULON Clémentine, COURBOIS Aymeric, COURTIN Jean, CROCHEMORE Sébastien, CUVELLIER Jeanette, DAILLIEZ Laurent, DAMOY Vincent, DEBACQ Alexis, DEHURTEVENT Nicolas, DELAVAL Aurélie, DELELIS Nicolas, DELME Coralie, DELSAUT Michel, DEMAGNY Gérard, DEMEURE Éric, DEPREZ Hubert, DESCAMPS M., DESMARES Thomas, DESREUMAUX Hugues, DESWARTWAEGER Christophe, DESWERTWAEGER Raphaëlle, DJIAN Jennifer-Laure, DUBOIS Claude, DUCHAUSSOY F., DUFOUR Rémi, ESPÉT Fred, FARGES Romain, FASQUELLE Isabelle, FAUCQUEZ Jacques, FAUPIN Grégory, FERMI Tiphaine, FIOLET Stéphane, FISCHER Suzanne, FLANDRIN Jacques, FLIPO Quentin, FOSSAERT Manon, FOULON David, FRAMMERY Romain, GABILLARD François, GAMELIN Pierre-Louis, GAYET Caroline, GEORGES Thibault, GILLEBERT Karl, GODIN José., GOVAERE Arnaud, GRANDVAL Vincent, GRAVE Pascal, GRILLAS Célia, GUEUESSE Laurent, HAINES Perry, HANOTTE Christine, HARLAY Frédéric, HEMBERT Juliette, HERMAN Sophie, HEROGUEL Clément, HERREMAN Laurent, HOUEN Charles-Edouard, HUART Michel, HUDELLE Philippe, HWRET S., JANCZAK Alexandra, KAMMACHER Elsa, KILHOFFER Maud, LAMBERT Marc, LAMBERT Ronan, LARIVIERE Serge, LAVOGIEZ David, LEFEBVRE Louis, LEGRIS Jean-Claude, LELEU Julien, LEMAITRE Dominique, LEMOINE Elyssa, LENGAGNE Romain, LETARD Valérie, LEURS Éric, LION Stéphane, LONGUESPE François, MACKE Joël, MAGNÉ I., MARECHAL Chloé, MASSEZ Grégoire, MÉZIÈRE Sébastien, MIEZE Jean-Claude, MIEZE Jean-Paul, MILARET Lucie, MILLOT Albert, MOEYS Marie, MONNET Sarah, MONTECH Cindy, MORDACQUE Christian, MOREL Céline, MOREL Régis, MOREL Xavier, MORELLE Christophe, MORLON Fabrice, NOWICKI Clara, PANOSSIAN Delphine, POTTERIE Alexandre, POULAIN Alexandre, POULAIN René, PREVOST Félix, PRUVOST Thomas, PUTOT Olivier, QUEVILLARD Robin, RACINE Steeve, RATIER Jean-Denis, REBERGUE Jean-Luc, RICOUART Francine, RIEKLINK Thierry, RISSER Serge, ROBERT Guy, SAINTMACHIN Hugo, SAISON Julien, SCHOUTEDEEN Dalila, SEILLIER F., SEYNAEVE Pierre, SHEIR Marc, SOLIVERES Raphaël, STOVEN François, SZUTKA C., TEICHMAN François, TELLIER Quentin, TERLUTTE Francky, THERY Christophe, THOMAS Marie-Blanche, THORIS Martin, TOULOTTE Fabien, TREUTENAERE Dimitri, TRIMBORN Philippe, VAHE Lucile, VANAPPELGHEM Cédric, VANCLEENPUTTE Paul, VANVINCQ Nicolas, VASSEUR Didier, VERLEY Céline, WARD Alain, WEINSTEIN Gwénaël, WILLEMETZ Sylvain., WILLEMIN Nicolas, WIMEZ Kevin, ZACHEE Priscilla.

The preservation of biodiversity cannot be overseen without solid data. The preservation act responds to specific scientific knowledge and addresses the need to maintain an ecological equilibrium.

Knowledge so gathered will be compiled, updated, clarified and consolidated in a database designed to guide administrators in making future development choices, as well as in articulating appropriate conservation management policies.

Programmes will be engaged on the one hand to better understand and monitor native population demographics, and on the other hand, to sustain the fight against mostly exogenous invasive species.

Extract from the 2013-2025 charter of the *Caps et Marais d'Opale* Regional Natural Park.
Second Orientation: To understand and preserve regional biodiversity.

espaces naturels régionaux NORD-PAS DE CALAIS

Maisons du Parc
> Manoir du Huisbois, Le Wast > Maison du Marais, Saint-Martin-au-Laërt • Adresse postale : B.P. 22, 62142 LE WAST • Tél. : 03 21 87 90 90 • info@parc-opale.fr • www.parc-opale.fr • Facebook : Parc Opale • Twitter : Parcopale

Parc naturel régional des Caps et Marais d'Opale

RÉGION NORD-PAS DE CALAIS · Pas-de-Calais Le Département · UNION EUROPÉENNE · l'Europe s'engage en Nord-Pas-de-Calais avec le FEDER · Liberté • Égalité • Fraternité RÉPUBLIQUE FRANÇAISE

Une autre vie s'invente ici