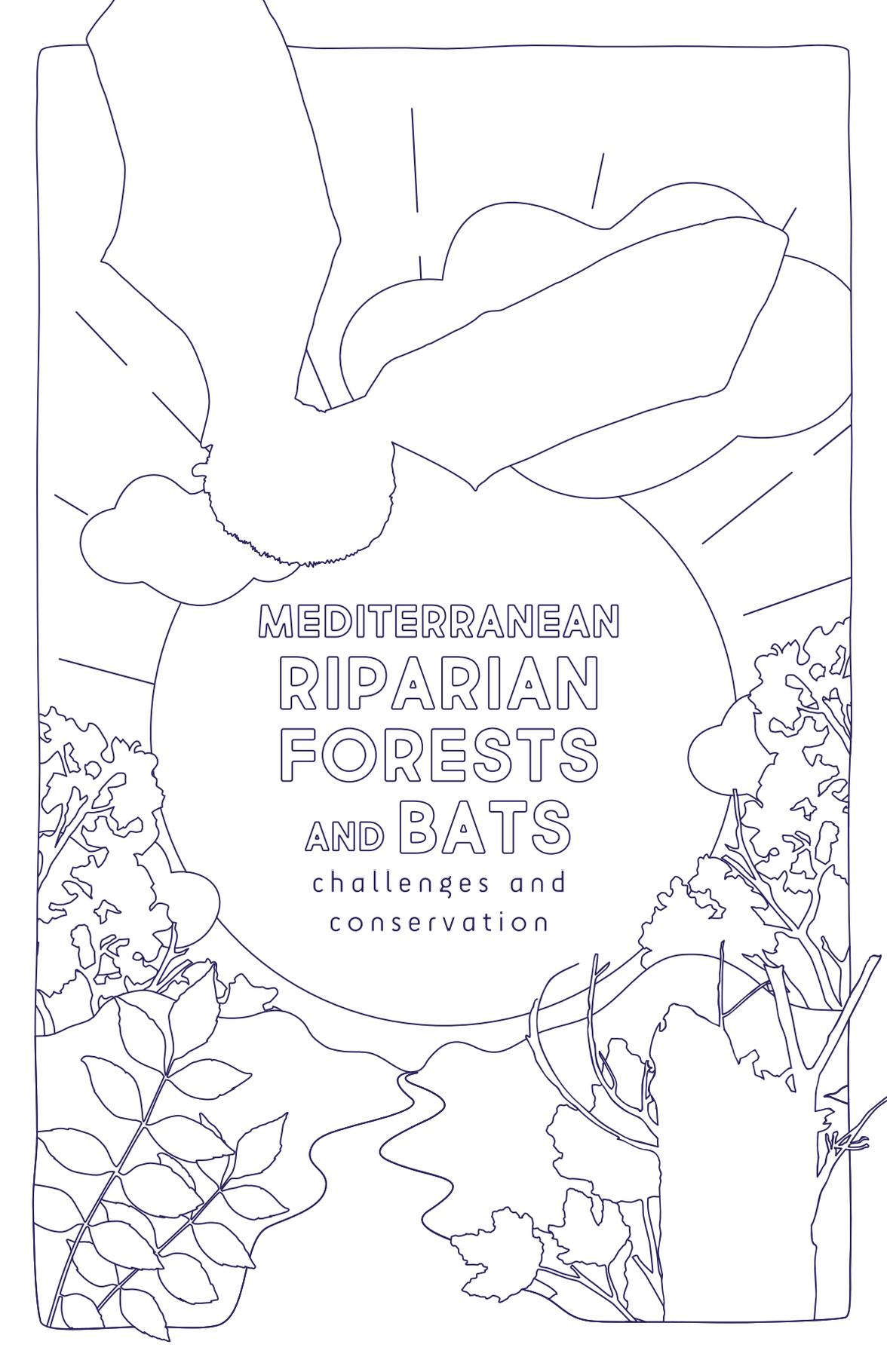




**MEDITERRANEAN
RIPARIAN
FORESTS
AND BATS**
challenges and
conservation

A line art illustration of a forest landscape. In the center, a large, stylized sun or moon is depicted with several short lines radiating from it. The background is filled with various tree silhouettes and foliage. In the foreground, there are detailed drawings of leaves and branches, including a large leafy branch on the left and a tree trunk on the right. The entire scene is enclosed in a simple rectangular border.

MEDITERRANEAN
RIPARIAN
FORESTS
AND BATS
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The riparian forest suffers from a lack of interest and knowledge which is also reflected in inventories and protected area designations with Natura 2000 sites of rivers where it is not included. Yet this environment is rare in our country, with a troubled history related to the vagaries of the climate and human action over the last centuries. Does it play only a minor role in our ecosystems?

This disinterest is also related to what the riparian forest is: spontaneous, dynamic and wild. It does not fit into western thinking which likes to classify. This does not favour its conservation; especially since riparian forests are recent and moving, establishing in areas

forgotten by man or 'recovered' by the river. They become then a lawless zone, a space seen as abandoned, illegitimate or to be conquered, finally an adjustment variable of our increasingly strong hold on natural areas.

Why were we interested in the relationship between riparian forests and bats?

In Chiroptera inventories, riparian forests have always been sampled: these habitats increase the probability of contacting bats which are always attracted to these wetlands*, but also sometimes enable us to connect with the last place of spontaneous nature in a site. At the same time, we noticed that some destruction was avoidable if the riparian forest and its issues were better recognised at all levels of design and appraisal of development projects.

Moreover, regular requests for information have emerged from local authorities, aware of the importance of these riparian environments and that the current management methods are not satisfactory. It is difficult however to provide clear, adapted and realistic answers. The feeling that an important issue was eluding us on Chiroptera communities and the functional role of riparian forests nurtured the idea of a study project.

How to approach the topic and for what purpose?

Our aim was to understand the relationship between bats and riparian forests in order to assess the biological and functional issues of this environment with the ambition of placing it back at the centre of reflections on the development and restoration of watercourses and their banks. Eight partners, river managers, showed a strong interest. They raised many other questions and expressed their practical needs. The heart of the project was to enquire into the role of old growth woods in riparian forests and the bat occupancy phenology. We also studied the ecological functional width of the riparian forest, the current practices, the complex legal framework, and identified conservation paths.



1

**RIPARIAN FORESTS,
BATS
AND MEN**





The preservation and sustainable management of wetlands* defined in Article L. 211-1 are of general interest. The national, regional and local rural development policies and the allocation of public grants take account of the particular difficulties of conserving, exploiting and sustainably managing wetlands* and their contribution to policies for the preservation of biological diversity, the landscape, water resource management and flood prevention, in particular through adapted agriculture, pastoralism, forestry, hunting, fishing and tourism.

In that respect, the State and its public institutions, the regions, departments, municipalities and their groupings ensure, each in their area of jurisdiction, the coherence of the various public policies in these territories. For implementing the X of Article L212-1, the State ensures that this coherence is taken into account in the water development and management schemes.

French Environmental Code

Article L211-1-1 / 23 February 2005



1

RIPARIAN FORESTS, definition, knowledge and threats

■ THE RIPARIAN FOREST

Let us start from the etymology: the latin, *ripa*, bank and *sylva*, forest, wood. A true interface between water and land, the riparian forest, also called alluvial or riverine forest, refers to all the herbaceous vegetation, shrubs and trees associated with a stream or a river  2. Its existence depends on a shallow water table; its dynamics are closely related to those of the watercourse [periodic flooding]. It is therefore a wetland* as defined in the Environmental Code.

Its interaction with water is such that its morphology is not restricted to a homogeneous structure but rather to a mosaic of forms, from the early pioneer stage dominated by the shrub layer to the mature stage dominated by woody plants. The fluctuating and heterogeneous nature of riparian areas gives them a richness in flora and fauna biodiversity, obligate aquatic species and forest species [1]-[3].

The term riparian forest does not imply a specific phytosociological* character.

However, the presence of water for varying periods of time is favourable to the installation of willows, alders and poplars on the edge of the minor river bed; when the environment stabilises or when we move away from the watercourse and its groundwater, maples, elms, pedunculate oaks or hornbeams appear.

Often unrecognised, it is part of what is now called ordinary nature. Since a few years, the vulnerability of so-called 'common' biodiversity has been brought to light by scientists; the issues related to their conservation are expressed ever more strongly [4], [5].



Riparian forest lower Argens, May 2010
© Alain Abba



Another major characteristic of this environment: it has been regularly modified, transformed by man's action  3. Man is an active component of the riparian forest system; we can therefore define it as a socioecological* system. Its approach requires all the complex interactions defining it, including those with humans [see the concept of Riparia*] to be taken into account.

In the Southern region, the riparian forest accounts for less than 1.6 % of the territory - the forests as a whole cover 51 %. Some types of Mediterranean alluvial forests have been included since 2018 in the Red List of Ecosystems in France prepared by the French Committee of the International Union for Conservation of Nature. This list makes it possible to assess the degree of threat to biodiversity at the ecosystem level. Mediterranean riparian poplar forests are considered as near threatened [6].



Development on the edge of the Durance river
© Électricité de France - Observatoire de la Durance 2017



■ HERITAGE INTEREST OF RIPARIAN FORESTS & FACTOR IN QUALITY OF THE LIVING ENVIRONMENT

The regular human intervention on riparian forests can be explained, beyond the utilitarian objective, by a desire for control favoured by an anthropocentric vision of man's existence in the living world. Yet it is incumbent upon us to prevent this fragile environment, which has become rare, from disappearing completely. It is part of our common natural heritage, a matrix which we all depend on.

Fauna and flora, an undeniable and recognised natural heritage

As a reminder, "the notion of natural heritage relates to biodiversity and especially the responsibility of current generations to pass it on to future generations. It brings together all the environmental wealth and resources [fauna and flora species, cultural assets, habitats, etc.]" [7].

The riparian forest, like other wetlands*, is a biodiversity-rich environment. Its complex structure is ideal for supporting diverse animal species. Riparian areas ensure the feeding and breeding of wildlife but also

fulfill a transit function through their corridor effect on the regional scale. The riparian forest therefore contributes to the maintenance of biodiversity by favouring the presence of diverse fauna and flora species.

It is fully integrated in the nature-based objectives for biodiversity conservation and the resilience* of territories pursued by the different governments [8], [9].



The cultural heritage, the importance of the landscape and the relationship with nature

Most of us have an attachment to the riparian forest landscape along rivers, whether it is a simple edging or a lush forest. This presence is so familiar to us that we end up forgetting it. But its absence would tarnish drastically our sensitive relationship with the natural landscape. The riparian forest is an integral part of the landscape structure and thereby contributes to improve the living environment and the attractiveness of the territory.

In urban environments, the riparian forest is sometimes the only 'island' of close accessible nature which provides a beneficial break to visitors in their multi-active daily life in a concrete environment. We have always had a close relationship with water; the observation of a stream or a river is conducive to contemplation. The alluvial forest is associated with this 'affective' relationship with water. Moreover, it enables us to let ourselves be carried along by observation and listening to the life it hosts. It becomes a recreation and educational area which can allow us to connect again to nature. At the time of climate change, it also provides in the summer a 'coolness island' that we should not neglect. Its heritage interest introduces a new basis for arguments to act for its protection and restoration.

To go further

The riparian forest, owing to its naturalness, offers a mosaic of untamed habitats. This aspect can cause a negative apprehension on our part. What is this place sometimes rendered inaccessible by a lush and free vegetation, which abounds with small unknown animals 📷 4? Our western societies have always sought to control nature and to situate themselves above their own state of nature and all the living creatures.

Does this stance not reveal a fear of nature which runs counter to the very conception of the current western thought opposing humanity and nature?

This fear nurtures the methods of intervention on nature which are today rooted in our practices. We prefer for example open environments to closed environments which appear scary.

By placing ourselves at our proper place, that is as one element among others in the living world, we will be able have a better consideration and acceptance of spontaneous, so-called wild nature and let it evolve freely without anxiety.



This thought developed in particular by the American forester Aldo Leopold in the first half of the 20th century (he is at the origin of the concept of *wilderness* which can be understood as large wild areas or naturality) is beginning to integrate into practices through the maintenance of senescence islands especially in logged forests [10].

Non-intervention in forested areas guarantees invaluable benefits as argued by the association Forêts sauvages [11].



The Petit Rhône river
© Fanny Albalat

THE CENTRAL PLACE OF RIPARIAN FORESTS, THEIR DIFFERENT ROLES

Small history of riparian forests

The sedentary lifestyle adopted by Man 10,000 years BC marks the beginning of its strong intervention on its environment [2]. The history of alluvial forests goes hand in hand with that of human activities. From the Roman empire through the Middle Ages to the 20th century, humankind, through its needs - farming, animal husbandry, metallurgy, shipbuilding, water development, quarries - and its growth, has undertaken more or less massive deforestation.

Even nowadays, the riparian forest remains an adjustment variable in development projects: transport infrastructure, dike construction, urban and agricultural expansion, etc.



The central place of riparian forests
© Jessica Antoine

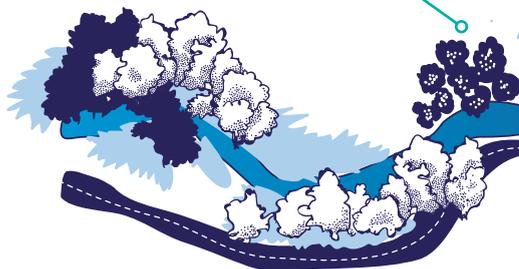


Hosting and movement of wildlife

Maintenance of water quality
The riparian forest filters the nitrates and phosphates and limits water pollution particularly in agricultural areas.

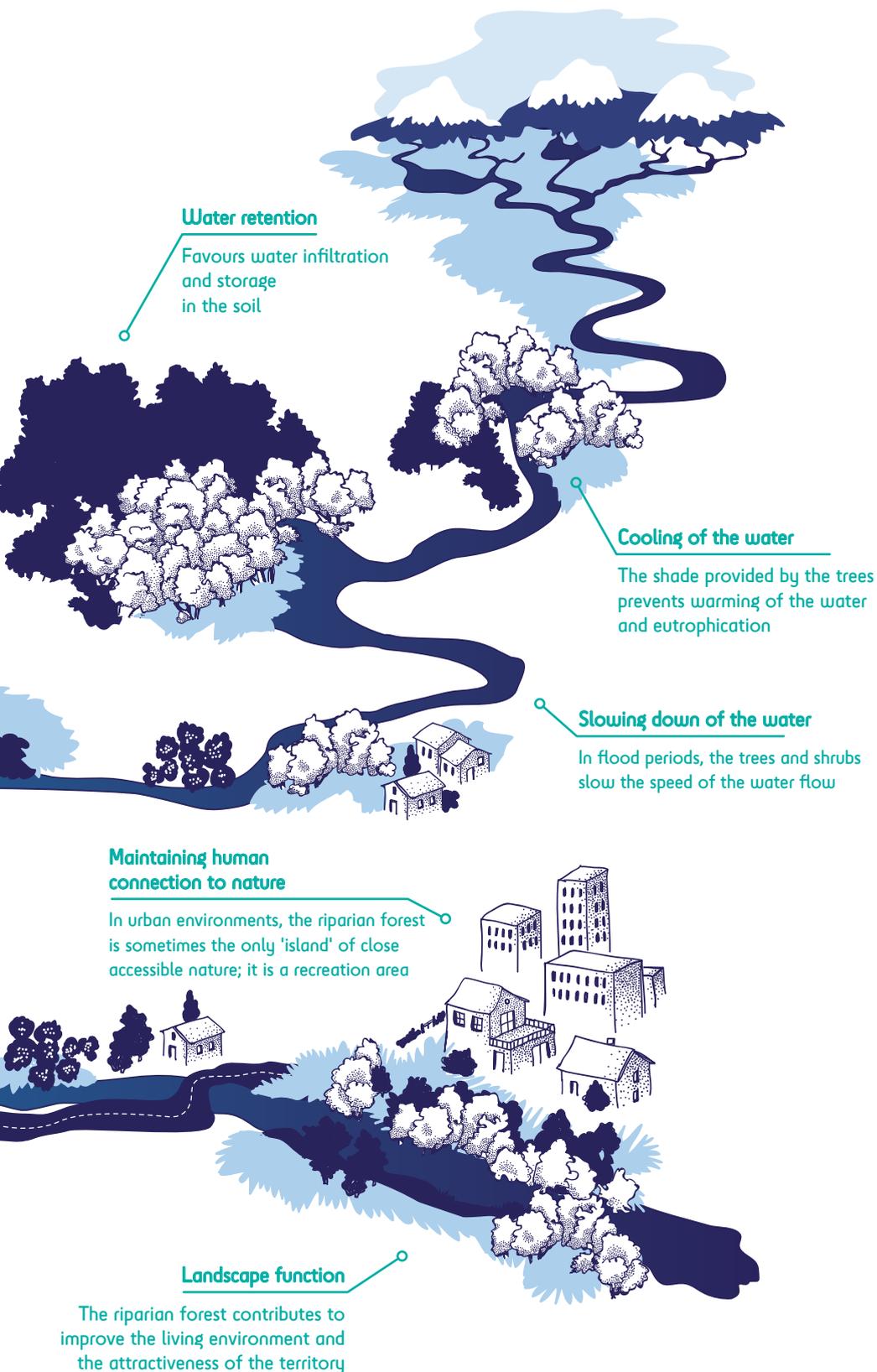


Limitation of the establishment of invasive species



Bank maintenance

The root system of the vegetation limits erosion of the banks by maintaining the soil





■ THE THREATS TO THE RIPARIAN FORESTS

Despite the history that closely links together man and water, the riparian forest habitat has never really been taken into account other than as a resource or areas to be used. Not easily accessible and not easily valuable economically, they have been and are still perceived as a source of constraint rather than as an asset or an area to be preserved simply for what it is.

Over the last centuries, river channelling, dike building as well as the expansion of agriculture and urbanisation very close to watercourses have led to the disappearance of the major part of riparian forests in the Southern region, often reducing them to narrow wooded corridors sometimes no larger than the width of a trunk. Nowadays, many threats to the remaining riparian forests still persist:

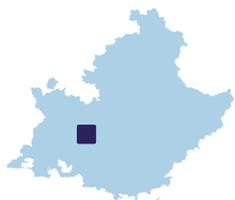
- the expansion of urban planning and agriculture,
- the restoration of dyking systems, accentuated by the recent transfer of the GEMAPI* competence to the municipalities and to the public establishments for cooperation between local authorities (EPCI), which often leads to the destruction of the nearby riparian forest,
- the clear-cutting carried out by private owners for the sale of wood [fuelwood].

The different business areas related to riparian forests each approach it according to their need: hydromorphological* vision for dyke managers, functional vision for the farmers and fishermen (influence on the purification and temperation of water), phytosociological* or ecosystemic vision for naturalists*, etc.

Everyone will have a different vision of the banks, their own definition of riparian forests. Moreover, their dynamics are related to the conditions of the soil, the weather, and the human activities surrounding them; so their appearance can change quickly.

Finally, although the Ministerial Decree of 24 June 2008 specifying the criteria for defining and delimiting wetlands* favoured the consideration of riparian woodlands, they are still not included on the wetland* maps  6.

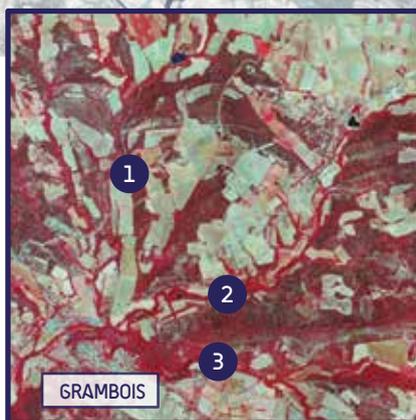
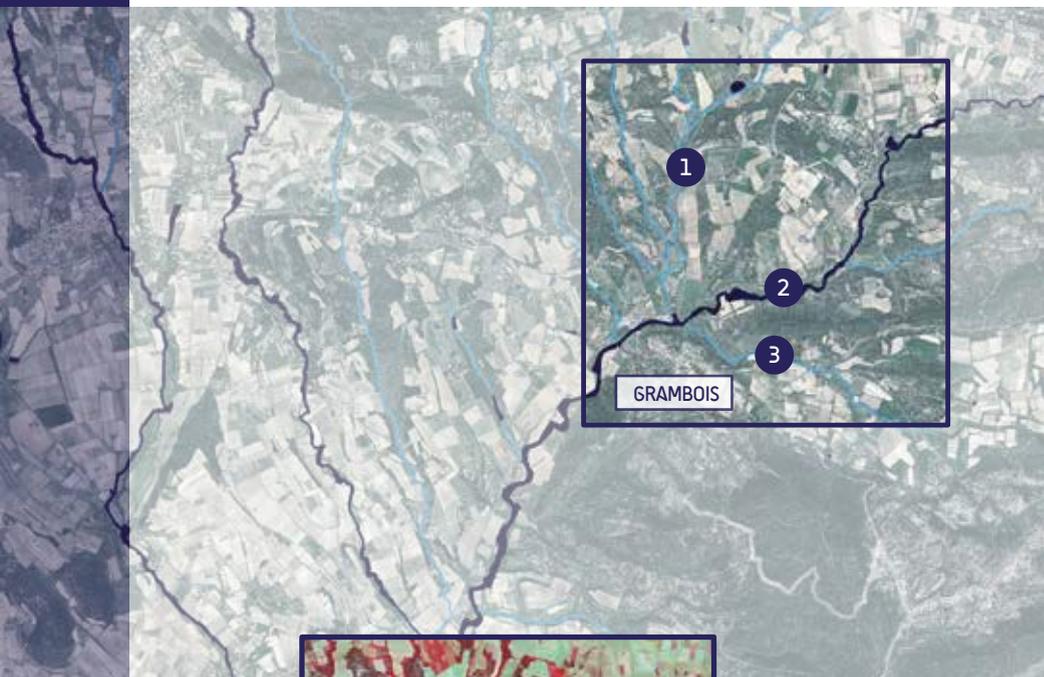
This fuzziness, this intermediate place between water and land as well as the many roles played by riparian forests  5 [p. 10-11] imply that the number of laws and decrees concerning them are multiple and sometimes counterproductive. This confusion does not enable us to give proper consideration to riparian forests in our socioecological system*.



6.a

Map of wetlands around Grambois, Vaucluse [DREAL PACA]

1



- Wetlands*
- ~ Watercourse
- 1 Torrent de Saint-Pancrease [Saint-Pancrease Torrent]
- 2 Èze river
- 3 Ravin du Coq

6.b

Infrared aerial photography zoom
IGN-2018-© BDOthoIRC
Copying and reproduction
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➤ This type of representation [6.b] is based on the greater or lesser capacity of the land cover to absorb sun rays, in particular infra-red rays. Thus, the more red the colour, the higher the chlorophyll photosynthesis activity. It reveals the high productivity in the Mediterranean region of riparian forests [in red] compared to dry forests [in darker colour]. In our example, some riparian forests, not taken into account in the mapping of wetlands*, seem to have their place in the inventory.

1.2

THE CHIROPTERANS, definition and bioindicator role

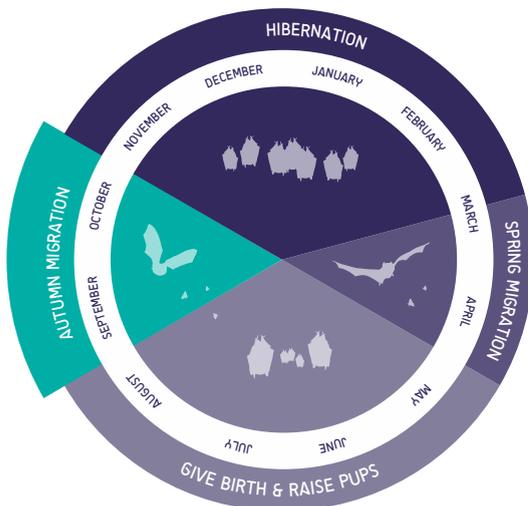
■ THE CHIROPTERANS

The origin of the word Chiroptera is Greek: *kheir* means hand, and *pteros* means wing, to recall that it is an animal that flies with its hands. Indeed, the membrane joining the fingers of a bat forms its wings. They are the only mammals capable of active flight.

The bats are nocturnal mammals, the size of the French species varies between 20 and 50 cm in wingspan and their weight between 4 and 25 g, exceptionally 60 g [11]. 8 and [12] 9. Insectivorous, they use echolocation to hunt and orient themselves. This capacity enables them to "see with their ears" by analysing the echoes of their ultrasonic calls like a sonar.

Their habitats are diverse: underground roosts, crevices and cracks in the rock walls, under the foliage, behind barks or in tree cavities. They also use a large proportion of man-made constructions: bridges, military structures, roof structures, cellars, mines, etc.

The Southern region is one of the richest regions in France in Chiroptera species: 30 species are present out of the 34 identified in the whole country. They are divided into 4 families: the Rhinolophidae, the Vespertilionidae [the most numerous one in Provence] the Minopteridae and the Molossidae [12]. They have a biological cycle based on the four seasons [11]. 7.



[11]. 7

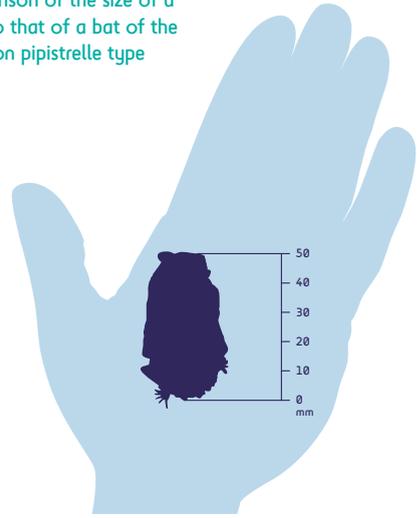
Biological cycle of Chiroptera

► Recommended period for all interventions or developments



8

Comparison of the size of a hand to that of a bat of the Common pipistrelle type



9

Leisler's noctule
© Tanguy Stoecklé

The Chiropterans, species protected since 1976, whereas their habitats are protected since 2007

Most of the French bat species are threatened or in decline. Indeed, they are vulnerable to certain human activities. Night-time light pollution, encroachment on natural areas while towns grow, or intensive agriculture and its array of pesticides lead to a strong degradation of the habitats used by bats.

The development of the road network and wind farms also causes a very significant direct mortality which affects all the species without exception. All these threats have led to a collapse of Chiroptera populations during the second half of the 20th century [13] which is still continuing today [14].

In order to curb this decline, all the French bat species are fully protected since 1976. It is prohibited to kill, capture or disturb them. The resting places, breeding sites, as well as the associated physical or biological elements, are also protected (Decree of 23 April 2007 listing the terrestrial mammals protected throughout the country and the terms of their protection). In short, the roosts and ecological continuities necessary for their reproduction are protected and must be maintained.

■ THE CHIROPTERANS AS BIOINDICATOR SPECIES

A bioindicator species is a species whose presence or status provides information on some ecological characteristics of the environment, of species communities, or on the impact of certain practices.



📷 10

Daubenon's bat
© Benoît Morazé

The European bats are highly specialised insectivorous species, which live for several decades and have a low reproductive rate [15].

They need many resources to maintain their populations; the fluctuations in their abundance can reflect changes within prey species populations or other factors.

They are also species sensitive to disturbance, which depend on the good functionality of ecosystems. Indeed, most European bats need ecological corridors to move [16] - [19] and are very sensitive to the fragmentation of their habitats [20] - [23].





📷 11

The Western barbastelle
© Erwann Thépaut

Each species of bat has its own ecological requirements

- some species such as the **Long-fingered bat** or **Daubenton's bat** 📷 10 hunt almost exclusively over watercourses where they fish insects present on the surface,
- the **European free-tailed bat** hunts several dozens or hundreds of metres above the ground where it captures large aerial insects,
- several species are dependent on the presence of specific natural and good quality habitats to maintain themselves. The **Western barbastelle** 📷 11 and **Bechstein's bat** are for example closely associated with arboreal micro-habitats* for the roost, to such an extent that the availability of roost trees is considered as a limiting factor* for their populations [24], [25]. They are therefore associated with mature and senescent woodland in free evolution where there is a large presence of roost trees.

Therefore, the bat species encountered in a site, owing to their specific ecological requirements, provide indications on the habitats present and their characteristics: connectivity, degree of senescence, etc.

Chiropterans are therefore considered as very good bioindicators of the quality of certain habitats and landscape components [26] - [28].

In the Mediterranean area, Daubenton's bat is considered as a bioindicator species for bank structure [29].

As part of the RipiMed project (Ripisylves Méditerranéennes - Mediterranean Riparian forests), we chose bats as biological indicators for the quality of the riparian forests sampled, based on the assumption that the group of species present as well as its degree of activity would give indications on:

- the degree of senescence of the woods,
- their degree of connectivity,
- their level of productivity in prey insects.

1.3

THE RIPIMED STUDY, Mediterranean riparian forests

■ THE RELATIONSHIPS BETWEEN CHIROPTERANS AND RIPARIAN FORESTS

The general objective of the RipiMed study was to study the relationships between Chiropterans and riparian forests, in particular senescent ones, in the Mediterranean area.

Two protocols were set up: the first to investigate the phenology* of use of riparian forests and the influence of the maturity of these woodlands on bat activity, the second one to study in particular the influence of the width. These two protocols were based on acoustic surveys [p. 20] and habitat surveys [p. 22].

Summary of the protocols

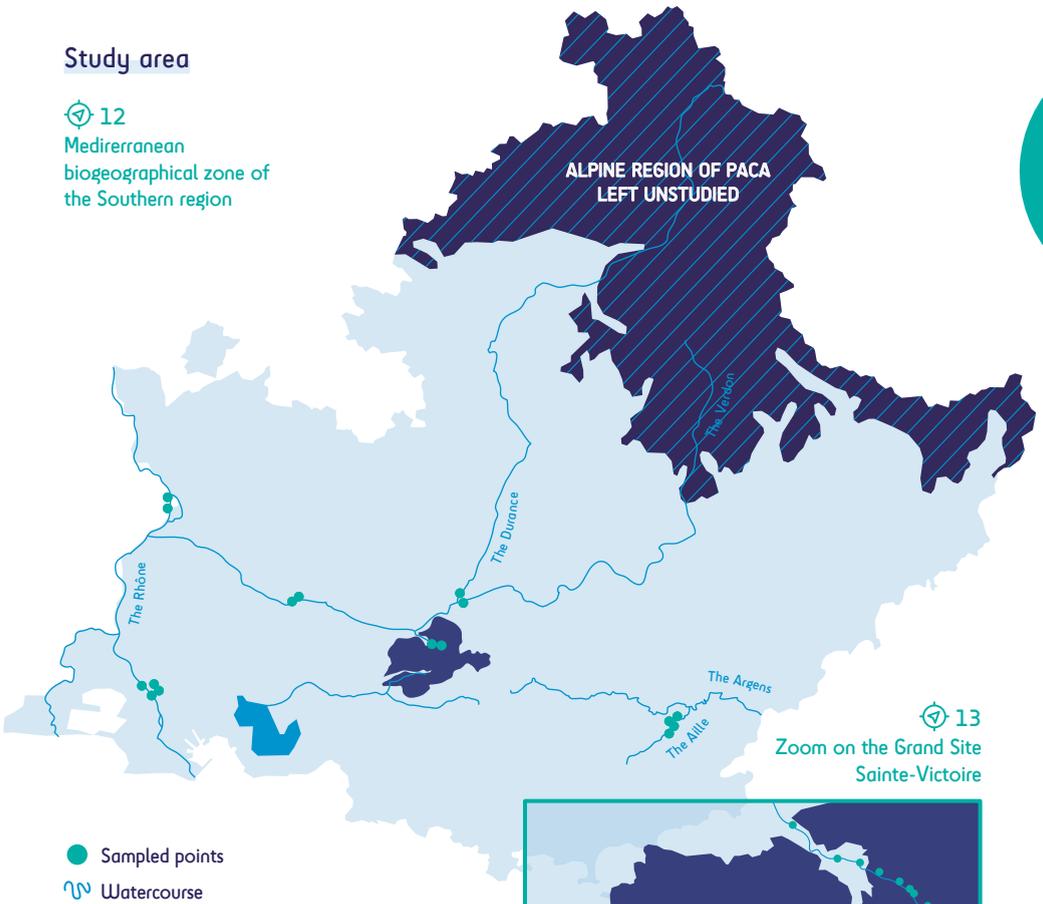
	12	13
	16 RIPARIAN FORESTS	33 RIPARIAN FORESTS
	8 mature / 8 non-mature on 4 watercourses	randomly selected on 3 watercourses
ACOUSTIC RECORDINGS	2 nights - SM4	1 night - SM4
SURVEYS	Once a month March to October 2018	1 week June 2018
OBJECTIVES	<u>Bat activities</u> <u>Phenology*</u> <u>Influence of maturity</u>	<u>Influence of the width of the riparian forest</u>

Two dry forests were also monitored as part of the first protocol, to monitor a possible shift in bat activity between dry forests and riparian forests in warm periods. This shift was not observed during the study. Nonetheless, these two points allow for a comparison, albeit non-statistical, of the two types of forests in their levels of use by Chiropterans.

Study area

📍 12

Medirreanean
biogeographical zone of
the Southern region



📍 13

Zoom on the Grand Site
Sainte-Victoire

In the French Mediterranean plains, riparian forests have the particularity of being one of the rare deciduous* woodlands. They largely escape the summer drought owing to their connection with the groundwater associated with the watercourse [30]. The persistent presence of water reduces hydric stress, moderates the summer temperatures [30] and enables the maintenance of high evapotranspiration levels. These increase the hygrometry rate of the air and are at the origin of an "oasis effect" [2]. The permanent presence of water is therefore a factor of productivity for riparian ecosystems 📍 6.a [p. 13].

Conversely, evergreen forest ecosystems that are not fed by water during the summer period suffer badly from the drought, which has a direct impact on their productivity levels [30]. So in the Mediterranean area, there

are pronounced summer production differentials between riparian ecosystems and dry forest ecosystems.

These differentials necessarily affect the animal communities they host. Riparian and aquatic habitats tend to concentrate the activity of Mediterranean bats in the summer drought period [31].

■ ACOUSTIC SURVEYS

Bats are flying mammals which orient themselves in space using echolocation [14]. Indeed, they emit ultrasonic calls and then listen to and analyse the returning echoes of these signals to build a 3D image of their environment. The sonar calls are modulated by individuals according to their environment, their degree of curiosity, or their speed.



[14] 14

Echolocation

[15 and 16]

The acoustic surveys

© Lorenza Buono and Lionel Bruhat - GCP

Like the different species of birds which each have their own songs, each bat species emits specific ultrasounds. The species-specific acoustic signatures are searched for during the ultrasonic inventories in order to identify them. The use of passive ultrasonic detectors* [SM2, SM4BAT FS developed by *Wildlife Acoustics*] is a particularly well suited method to study bat activity. This technique with no impact consists in recording the ultrasounds emitted by bats and enables large volumes of data to be gathered over long periods of time [15 and 16].

In our study, SM4s were installed always at the same point from one month to the next, every month from March to October 2018, during two nights. They were programmed with the parameters of the fixed point protocol of Vigie-Chiro* defined by the French National Museum of Natural History [32].



The sound analysis was performed using the SonoChiro® software [33] with manual correction. The determinations were made by group of species according to the ACTICHIRO* [34] reference tool, a list of species was also established for each night of recording.

The Chiroptera inventories for Appropriate Assessment and impact studies

Within the framework of impact studies or "Appropriate Assessment" (under the European Habitats Directive), for the collected data to be the most representative of the populations studied, it is necessary:

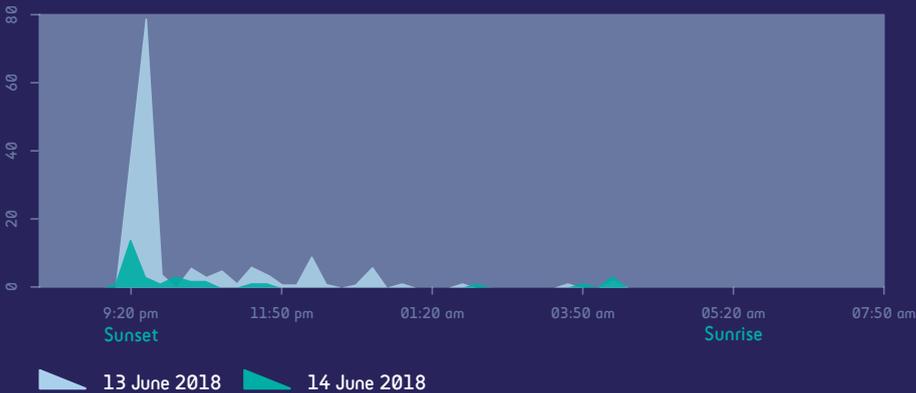
➤ to install ultrasonic detectors in different environments according to the needs and the study area: **for example, the Lesser mouse-eared bat** is a species found mainly in open environments (meadows, fields, etc.), so multiplying listening nights at different points can be more efficient than several nights at a same point [35],

➤ to survey in different seasons: for example, the **European free-tailed bat** is nearly absent in the summer [17] (p. 33), which is generally the preferred period for inventories,

➤ to install the detectors all night and for several nights: there is a very high inter-night variability, related in particular to the weather and the season [17]. B. Law and his team have shown that 6 consecutive nights are necessary for an effective inventory. This number should even increase to detect rare species [35].

[17]

Activity in number of ultrasonic contacts* per quarter of an hour from the start of recording; we observe peaks of activity during the night; from one night to another, the activity is multiplied by + 4



Once the recordings are acquired, there is still a process of sound counting and analysis using software (SonoChiro@ [33], Tadarida [36]).

This software enables an automated analysis of the sound extracts, and proposes a list of identified species with error rates. This analysis is only a stage of pre-treatment of the sound recording data.

It is important to note that these tools are recent and are not foolproof. It is therefore necessary to have the results validated by a chiropterologist, human skills being essential.

Finally, to assess the travel routes, a hand-held detector with a visual control are used to check whether the previously selected corridors are used or not.



■ THE HABITAT SURVEYS

Habitat surveys were performed at each of the listening points defined in an area of 15 m radius centred on the acoustic detector.

The variables taken into account were related to the structure of the riparian forests (cluttered state of the vegetation strata, plant diversity,...), to the degree of senescence of the woodland (number of arboreal roosts per tree, quantity of standing and fallen dead wood,...), to the structure of watercourses (minor river bed width,...) and to the level of connectivity of the riparian forest with the surrounding woodlands.

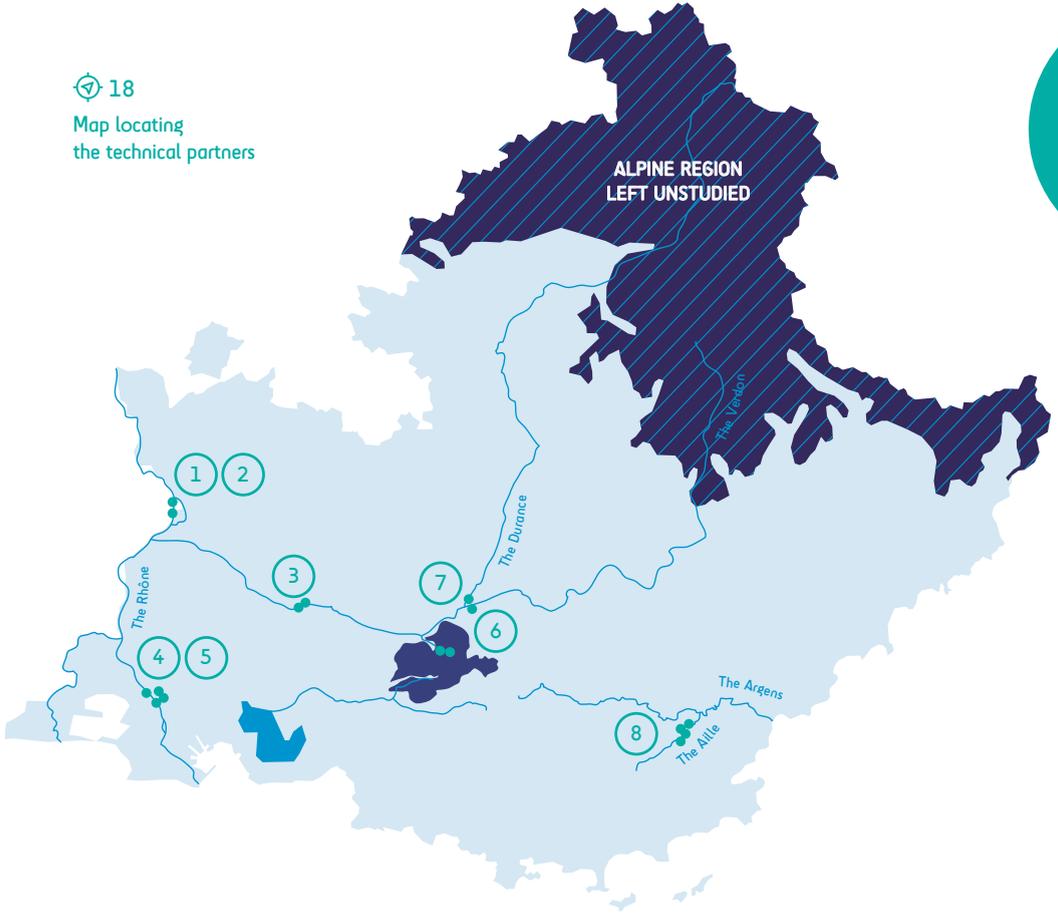
Furthermore, a published index was tested to characterise the ecological quality of the riparian forests and provide a monitoring tool for future management/restoration: the QBR index for *Qualitat del Bosc de Ribera* [37] developed by a team of Catalan researchers. It qualifies the river banks by assigning ratings to the structure of the vegetation present and to the structure of the banks and watercourse. A final rating thus enables the banks to be ranked according to their status.



■ TECHNICAL PARTNERS

The study was carried out in partnership with various stakeholders related to the riparian forest issue  18.

The partners participated in the site selection, in the data collection in the field, in the bibliographic research and in the reporting per territory. These five reporting meetings and ten workshops were organised on various themes: risk management, agriculture, land clearing, etc. Sixty players, managers of natural areas, Natura 2000 project coordinator(s), representatives of the Direction départementale des Territoires (DDT-Departmental Directorate of Territories) and the Direction régionale de l'Environnement, de l'Aménagement et du Logement (DREAL - Regional Directorate of Environment, Development and Housing) Provence-Alpes-Côte d'Azur, of the Rhone Mediterranean Corsica Water Agency, consultancy firms and associations could thus participate and debate around the study's results but also around points of conflict and existing solutions in the management of riparian woodland.



① The Compagnie Nationale du Rhône



② The Conservatoire des espaces naturels [Conservatory of natural areas] Provence-Alpes-Côte d'Azur



③ The Syndicat Mixte d'Aménagement [Joint Planning Association] of the Durance Valley



④ The Regional Nature Park of Camargue



⑤ The Tour du Valat



⑥ The Grand Site Sainte-Victoire Aix-Marseille-Provence Metropolis



⑦ Électricité de France



⑧ National Nature Reserve of the Plaine des Maures - Var Département



**THE RIPARIAN FOREST,
A HABITAT WHICH SHOULD
BE KNOWN, RECOGNISED
AND PRESERVED
RESULTS & RECOMMENDATIONS**





THE RIPIMED STUDY SEEN BY...

I immediately perceived the interest of proposing the Plaine des Maures National Nature Reserve for this study in order to bring to light the important role of riparian forests for the wildlife of Mediterranean dry forest and maquis habitats. As the manager of a protected area, the RipiMed study provides me with concrete elements on Chiropterans that enable me to better assess the optimal and functional widths of the riparian forests to be conserved or restored."

DOMINIQUE GUICHETEAU— Scientific Director
National Nature Reserve of the Plaine des Maures, Var
Department

At the beginning of the RipiMed study, the questions on the relationships between Chiropterans and alluvial woods concerned riparian forests as breeding or wintering habitats, hunting or transit habitats. Indeed, very few [or no?] colonies are known in the riparian forests of the Durance river. Is this a gap in the surveys or a real local particularity? Given the alluvial dynamics which periodically regenerate the habitats and the regular grubbing works carried out by EDF in the Durance river, what are the interests of the different maturity stages of the riparian forest for bats?

Finally, what about the use of wooded banks as ecological corridors for bats? What is the minimum structuration required for these woodlands to start to be functional [vertical structure, thickness, what length for tolerated openings...]?

While some questions require further investigations, the RipiMed study conducted by the Chiroptera Group of Provence has already started to answer some of them. These results will enable the concrete implementation of riparian forest management or restoration."

FRANÇOIS BOCA— Ecology Mission Head
Syndicat Mixte d'Aménagement
de la Vallée de la Durance [Joint Planning
Association of the Durance Valley]

2.1

THE CHIROPTERA SPECIES found in riparian forests

Among the 30 bat species found in the Southern region, and the 22 species of the Mediterranean biome, 21 species were contacted in riparian forests in the context of the RipiMed project [19].

Vernacular name	Scientific name	National protection ¹	Red List France ²	Habitats Directive ³	Regional conservation issue [12]
Western barbastelle	<i>Barbastella barbastellus</i>	Art.2	LC	Annex II and IV	Very strong
Bechstein's bat	<i>Myotis bechsteinii</i>	Art.2	NT	Annex II and IV	Very strong
Long-fingered bat	<i>Myotis capaccinii</i>	Art.2	NT	Annex II and IV	Very strong
Lesser mouse-eared bat	<i>Myotis oxygnathus</i>	Art.2	NT	Annex II and IV	Very strong
Schreiber's bat	<i>Miniopterus schreibersii</i>	Art.2	VU	Annex II and IV	Very strong
Geoffroy's bat	<i>Myotis emarginatus</i>	Art.2	LC	Annex II and IV	Strong
Greater mouse-eared bat	<i>Myotis myotis</i>	Art.2	LC	Annex II and IV	Strong
Greater horseshoe bat	<i>Rhinolophus ferrumequinum</i>	Art.2	LC	Annex II and IV	Strong
Lesser horseshoe bat	<i>Rhinolophus hipposideros</i>	Art.2	LC	Annex II and IV	Strong
Greater noctule bat	<i>Nyctalus lasiopterus</i>	Art.2	VU	Annex IV	Strong
European free-tailed bat	<i>Tadarida teniotis</i>	Art.2	NT	Annex IV	Strong
Serotine bat	<i>Eptesicus serotinus</i>	Art.2	NT	Annex IV	Moderate
Leisler's noctule	<i>Nyctalus leisleri</i>	Art.2	NT	Annex IV	Moderate
Nathusius's pipistrelle	<i>Pipistrellus nathusii</i>	Art.2	NT	Annex IV	Moderate
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	Art.2	LC	Annex IV	Moderate
Savi's pipistrelle	<i>Hypsugo savii</i>	Art.2	LC	Annex IV	Weak
Daubenton's bat	<i>Myotis daubentonii</i>	Art.2	LC	Annex IV	Weak
Natterer's bat	<i>Myotis nattereri</i>	Art.2	LC	Annex IV	Weak
Grey long-eared bat	<i>Plecotus austriacus</i>	Art.2	LC	Annex IV	Weak
Kuhl's pipistrelle	<i>Pipistrellus kuhlii</i>	Art.2	LC	Annex IV	Weak
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	Art.2	NT	Annex IV	Weak

Group of dominant species ■
Group of companion species ■

[19]

Species contacted during the study (the non-contacted species is the Mediterranean horseshoe bat which has almost disappeared from the Southern region) and associated regulations: ¹Decree of 23 April 2007 listing the terrestrial mammals protected throughout the country and the terms of their protection; ²Red List of threatened species in France - Mammals of metropolitan France, IUCN, 2017 [VU = vulnerable, NT = near threatened, LC = least concern]; ³Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora



📷 20

Geoffroy's bat

© Jean-Michel Bompar

The analysis of species occurrence at the various points showed the dominant group of species most frequently contacted in riparian forests in the context of the study: Leisler's noctule and the Soprano pipistrelle, known to be species associated with woodland and wetlands*, the Common pipistrelle and Kuhl's pipistrelle, which are also present in riparian woods. These two undemanding species are found in most Mediterranean habitats. The group is completed by Natterer's bat, which is essentially a forest species, and the European free-tailed bat which is a high-flying bat.

The group of companion species is comprised of two forest species, the Western barbastelle and Geoffroy's bat 📷 20. This last species is rare and located in the Mediterranean area. Many colonies known in the middle of the 20th century have disappeared [1,2]. Riparian forests are one of the preferred hunting habitats of the species. The maintenance of these riparian woodlands is therefore necessary for the conservation of the species. Daubenton's bat, a species closely associated with watercourses for hunting and the Serotine bat complete the group. This last species is little specialised and is encountered in most habitats in Provence, in particular near urban areas and along watercourses.

The nine preceding species are the most common in the riparian forests studied but many other bat species also use these woodlands. Several of them are rare or threatened:

➤ Bechstein's bat, very rare in the Mediterranean plains of the Southern region, is found however in certain high quality natural habitats such as some old riparian forests well connected to the surrounding landscapes. This species depends on the availability of many roost trees to maintain itself. When it is present, it is therefore indicative of the senescence of the woodland and of the good state of connectivity of ecological corridors.

➤ Nathusius's pipistrelle is a small bat weighing between 6-15 g which performs a migration of more than 1 000 km every year from the south of France to the north-east of Europe to give birth. During this migration, this species follows the watercourses and their riparian forests which are essential to it: real flight routes, they provide roosts, preferred hunting grounds and mating sites.

➤ the Greater horseshoe bat can live more than 30 years. It is in strong decline in the Mediterranean plains of the Southern region. The disappearance of the hedgerow networks and riparian forests is very harmful to the species, both for hunting and for its flight routes. For this reason, the presence of the species is indicative of the functionality of ecological corridors.



2.2

THE FUNCTIONAL ROLE of riparian forests for Chiropterans

Generally speaking, riparian forests have many functional roles for bats. They fulfil all the key needs of a life cycle: breeding, resting or hibernation roosts, feeding and drinking, movement, meeting and display.

■ INFLUENCE OF SENESCENCE

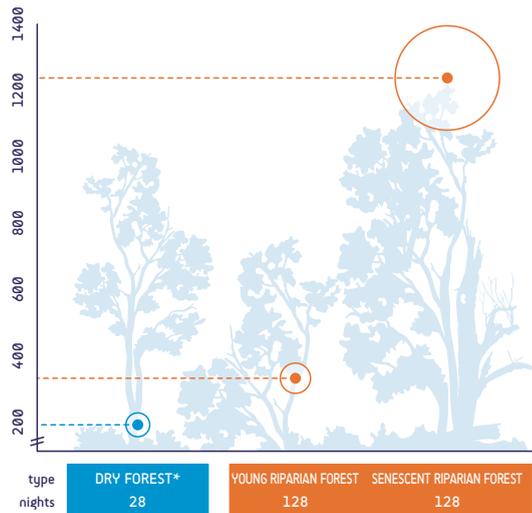
Senescence is a stage which enables the woodland to fulfil all its functional roles.

The results of the RipiMed study highlight the major role played by senescent riparian forests for Chiropterans.

Senescent riparian forests record 3.7 times more ultrasonic activity than young riparian forests [Fig. 21](#), it is a significant difference [p-value: 8.5×10^{-26}]¹. Indeed, senescent riparian forests have characteristics that are useful [Fig. 23](#) for bats at different levels: for roosts, hunting and movements.

[Fig. 21](#)

Bat activity, in average number of contacts per night, according to the type of woodland



*only 2 listening points studied against 16 in riparian forests

- Average number of contacts with bats per night in riparian forest
- Average number of contacts with bats per night in dry forest
- Standard error

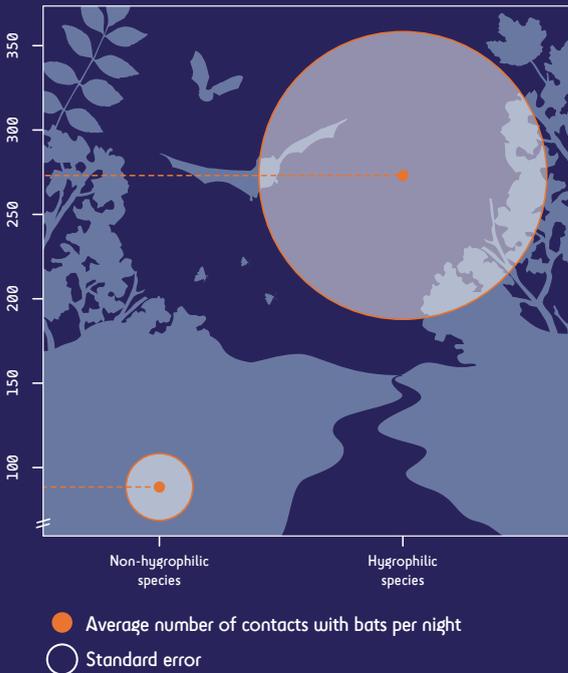
¹ Generalised linear model with the territory and the month as random variables with a negative binomial distribution on 256 observations 6 territories (Camargue, Avignon, Lower Durance, Middle Durance, Plaine des Maures, Grand Site Sainte-Victoire) and 8 months [from March to October]

Effect of water presence

The second protocol deployed in the Grand Site Sainte-Victoire showed that a riparian woodland whose dominant species is not hygrophilous* (case of intermittent watercourses for example) remains less favourable in terms of acoustic activities than the adjacent "hygrophilous*" stands [Fig. 22](#). This difference is even significant for the Pipistrelle group [p-value: 0.01]².

Fig. 22

Activity of the Pipistrelle group in average number of contacts per night according to the hygrophily* of the dominant species that make up the woodland



[Fig. 23](#) Structural characteristics between the young and senescent riparian forests monitored during the protocol 1

Variables recorded on the plots - 707 m ²		Young	Senescent
Woodland structure	Average height of the tree stratum [m]	20.5	27.9
	Cover of the low shrub stratum, less than 3 m [%]	23.3	18.6
	Cover of the high tree stratum, between 3 m and 7 m [%]	27.5	29.8
	Cover of the tree stratum, above 7 m [%]	47.3	49.1
Dead wood	Tree species diversity [1-Hill's diversity index]	0.7	0.8
	Proportion of large-sized trees [%]	1.4	16.2
	Average number of openings	0.8	1.6
Micro-habitats	Average quantity of dead wood on the ground [m ³]	1.6	5.1
	Average quantity of dead standing wood [m ³]	3.1	9.6
	Dominant micro-habitat type	creeper	microcavity
	Average number of potential micro-habitats [all types taken into account] per tree	0.9	2.9
	Average number of different micro-habitat types	4.0	4.9

We observe more dead wood and micro-habitats for the senescent forests: they were the criteria used for selecting the mature riparian forests monitored during the study, as suggested in the technical guide "Bois senescents" [senescent woods] [\[38\]](#). The dominant type of micro-habitat speaks for itself: it is ivy in young riparian forests, whereas in senescent forests, they are the microcavities made by xylophagous* insects. The senescent riparian forests have more openings, less cover of the low shrub stratum, and have a higher tree stratum on average. These characteristics favour well-marked storeys and edge effects appreciated by Pipistrelle or Mouse-eared bat species.

²Generalised linear model with the watercourse as random variable with a negative binomial distribution on 33 observations 3 watercourses [Réal, Cause and Bayon]

■ THE MICRO-HABITATS AND THE ROOST

The riparian forests serve in the first place as roosts for bats, which they use to shelter, give birth, raise their young, or to hibernate. For 20 evenings of search in woodlands, 5 arboreal roosts were discovered in riparian forests during the RipiMed study.

These roosts were all located in senescent trees with microcavities  24 to 27.



 24



 25



 26



 27

 24

A colony of Western barbastelles
under a loose
bark scale of an elm tree
© Lionel Bruhat - GCP

 25

Western barbastelle
© Raphaël Sané

 26

Several Leisler's noctule
individuals observed in a woodpecker
hole in a white willow
© Lionel Bruhat - GCP

 27

Leisler's noctule
© Jean-Michel Bompar

It is important to note that the more senescent a woodland is, the more roost possibilities it will offer for Chiropterans. All tree species are potentially favourable for roosts insofar as cavities are present. Old trees with large diameters are often rich in cavities and thus play a key role for the roosts of Chiropterans [39],[40]. We note however that some young trees or trees with small diameters also serve as roosts in particular owing to the presence of cracks and loose barks. We observed this in our study with a standing dead English elm which had a 31 cm diameter, or a white willow with a 40 cm diameter.

Finally, all the cavities such as woodpecker holes tend to appear more quickly in riparian forests due to the presence of softwood [41] and to a rapid growth.

HUNTING

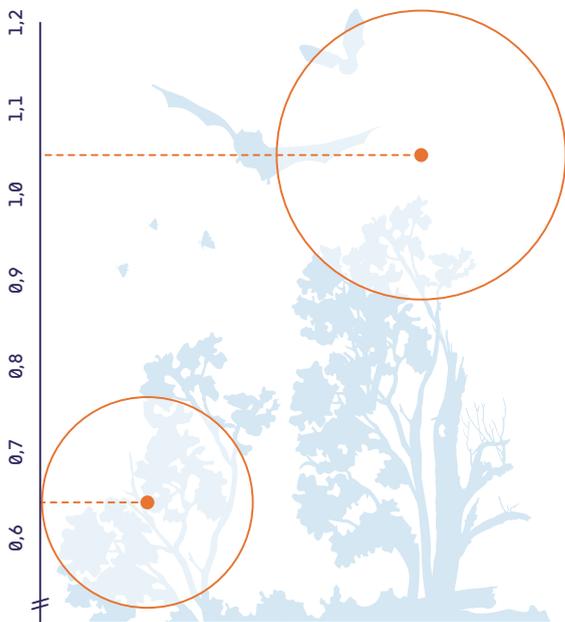
Bats emit capture buzzes [acceleration of the rhythm of ultrasonic calls] as their prey approach; these buzzes were recorded and counted to compare the hunting activity between young and senescent riparian forests.

Riparian forests are preferred hunting grounds for bats. These woods are associated with the presence of water which enables the development of rich and diverse insect communities with occasional emergence* phenomena.

As shown by the RipiMed study, bats use these habitats to feed: the hunting index, calculated by dividing the number of buzzes

by the number of contacts is 1.6 times higher in senescent riparian forests than in young riparian forests (7 times more in number of raw buzzes), there again the difference is significant [p-value: 0.02]³. This significant difference can be partly explained by the much greater presence of dead wood in senescent riparian forests (3 times more on average in the study) which enables the appearance of groups of saproxylophagous* insect species.

Furthermore, the structural diversity of senescent woods [vertical structuring with understoreys, more openings created by windfalls*] favours the presence of a larger number of bat species using distinct ecological niches*. For this reason, senescent riparian forests are used by a higher bat diversity than young riparian forests on average although this is not significant [11] 28.



Type of woodland/

YOUNG RIPARIAN FOREST

SENESCENT RIPARIAN FOREST

● Number of buzzes divided by the number of contacts per night

○ Standard error

[11] 28

Hunting index of the Pipistrelle group according to the type of woodland

³Generalised linear model with the territory and the month as random variables with a negative binomial distribution on 256 observations 6 territories [Camargue, Avignon, Lower Durance, Middle Durance, Plaine des Maures, Grand Site Sainte-Victoire] and 8 months [from March to October 2018]

MOVEMENT

The important role played by riparian forests as travel routes is a known element. Most Chiropterans depend on vegetated ecological corridors to move.

In the Mediterranean plain, riparian forests are often the last linear elements that structure the landscape on a large scale. Several studies underline the importance of these woodlands for bat movements [16]–[18]. A telemetric monitoring carried out in Camargue on the **Greater horseshoe bat**, for example, revealed that the monitored individuals preferred, at the exit of the roost, to make a 3 km detour by following the riparian forest of the Rhone river rather than to perform a direct flight of 4 km without cover [42]. These ecological corridors enable bats to orient themselves [43], to colonise new territories [19] and reduce their predation risk [44]. Tolerance to discontinuity in the linear woodland depends on the species. For the **Greater horseshoe bat**, they must not exceed 38 m where one individual out of two no longer crosses. Beyond 50 m, the break in continuity is an impassable obstacle for the species [23]. The opening width of 40 m has an impact on the general activity of Chiropterans [45]; 10 m is already difficult to cross for young bats in the learning phase.

On the other hand, in our study, **Bechstein's bats** were contacted only in riparian forests connected to other woodlands and located in a diverse landscape, which supports the importance of the connectivity of wooded environments for Chiroptera populations.

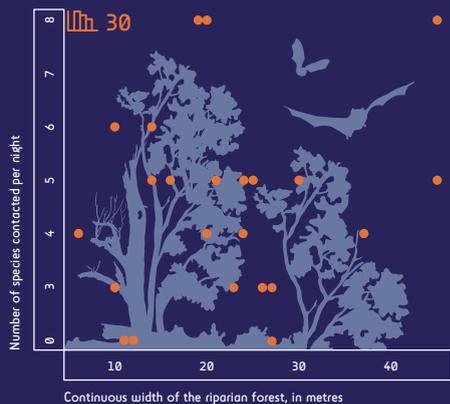
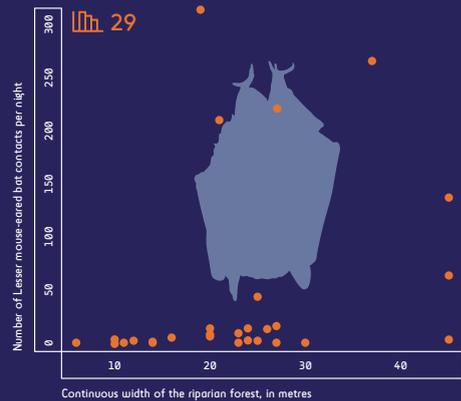


Influence of the width

The RipiMed study revealed a significant decrease of bat activity from 50 m for the group of **Pipistrelles** (p-value: 0.045) or 40 m for the group of **small-sized Mouse-eared bats** **Fig. 29** (p-value: 0.03)⁴, with a marked deflection around 30 m. It is a continuous width, i.e. it includes the two banks when the watercourse is narrow (Réal, Cause, Bayon) but only one when the watercourse is large (Durance river). But no influence of the width on diversity was found **Fig. 30**. Thin riparian forests therefore remain important for all species: a priori the role of movement corridor remains functional.

Fig. 29 Activity of small-sized mouse-eared bats, in number of contacts per night, according to the continuous width of the riparian forest

Fig. 30 Number of species contacted per night according to the continuous width of the riparian forest



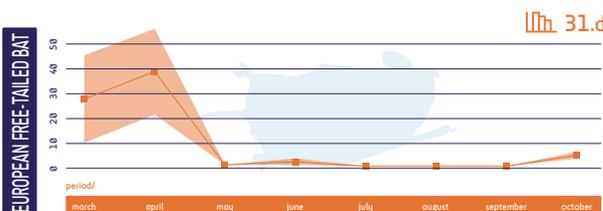
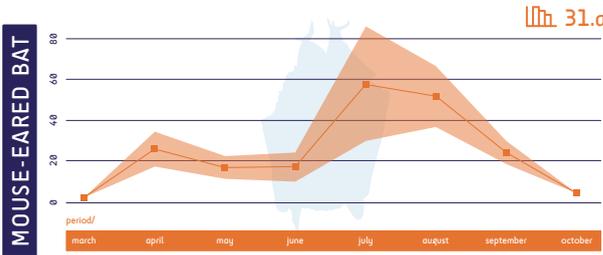
⁴Generalised linear model with the watercourse as random variable with a negative binomial distribution on 33 observations 3 watercourses (Réal, Cause and Bayon)

THE PHENOLOGY OF USE

Riparian forests are used by bats throughout the year. The phenology* of use of these moist woods varies according to the species [Fig. 31](#).

According to its diverse ecological needs, each bat species therefore uses the riparian forests. Some species such as **Bechstein's bat**, the **Soprano pipistrelle** [\[46\]](#) and the **Western barbastelle** [\[47\]](#) use them all year round; others such as the **European free-tailed bat** [Fig. 31.d](#) are only occasionally present but with high activity levels.

Riparian forests are ideal habitats for most of the Chiroptera species identified in the Southern region. Their small size coupled with the anthropogenic pressure they are subject to make them a major issue for bat conservation [\[12\]](#).



[Fig. 31](#)

Activity (in number of ultrasonic contacts* per month), over the period from March to October 2018, of the group of small-sized mouse-eared bats [Fig. 31.a](#); of Pipistrelles [Fig. 31.b](#); of Serotines-Leisler's noctules [Fig. 31.c](#); of European free-tailed bats [Fig. 31.d](#)

The group of **small-sized Mouse-eared bats** and the group of **Pipistrelles** are present from March to October with an increase of activity during the summer period corresponding to parturition and raising of the young.

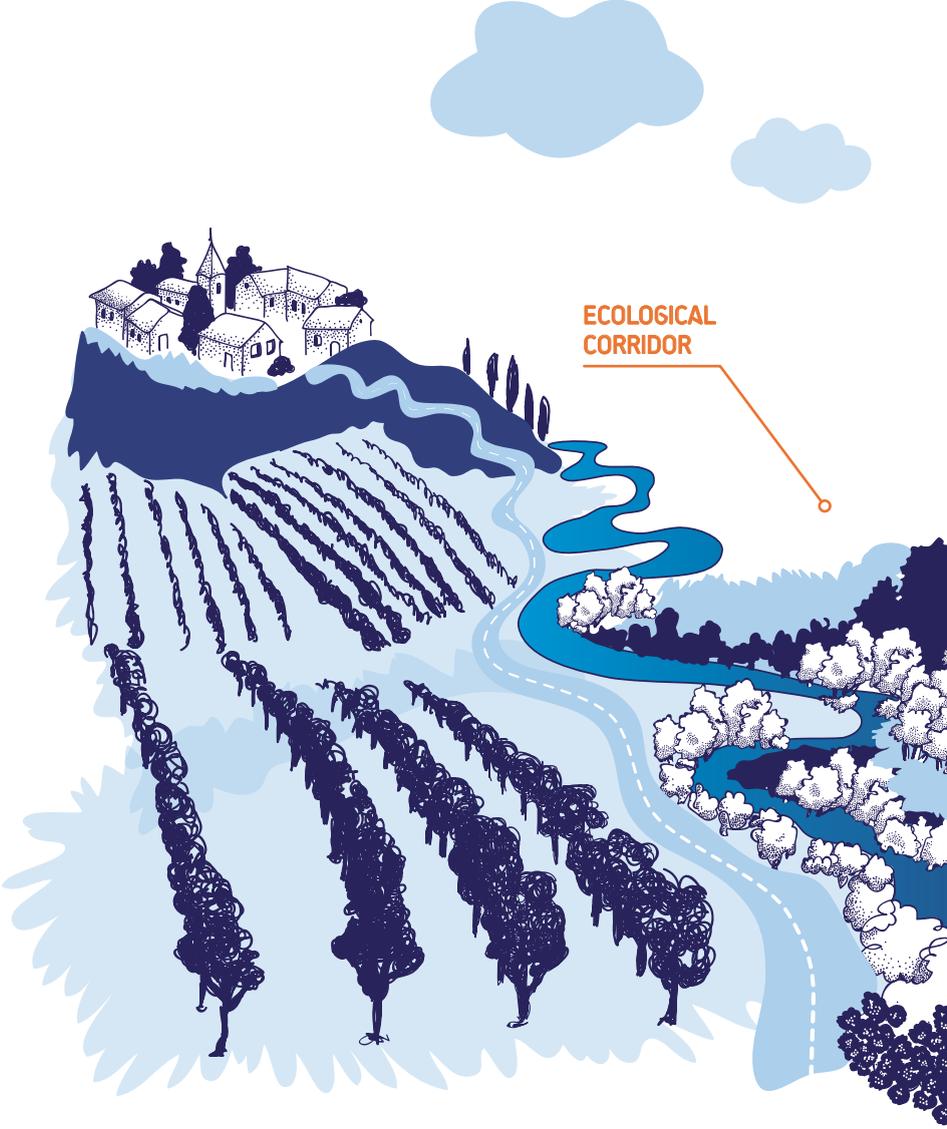
The Serotine-Leisler's noctule group (consisting of **Leisler's noctule** and the **Serotine bat**) shows a marked increase of its activity in the autumn season. This activity is essentially the result of the increase in the social calls emitted by males to attract females.

The **European free-tailed bat** is mainly present at the end of winter and in the autumn; this can be the sign of a movement of populations towards more favourable altitudes, as suggested by some naturalists*.

THE FUNCTIONAL ROLES OF THE RIPARIAN FOREST

32

© Jessica Antoine



ECOLOGICAL CORRIDOR

Young riparian forest



HUNTING

ROOST AND
DISPLAY

THE RIPARIAN FOREST, A HABITAT WHICH SHOULD BE KNOWN, RECOGNISED AND PRESERVED

Senescent riparian forest

2.3

RECOMMENDATIONS FOR riparian forest management

■ FREE EVOLUTION AS THE IDEAL SOLUTION

The recommended management is free evolution  33. This non-intervention enables the forest to find its natural equilibrium.

The ecological interest of riparian forests is accentuated by the presence of standing or fallen dead wood, micro-habitats* and water, by the diversity of shrub and tree species, and structures such as openings left by windfalls*. All these properties appear naturally in riparian forests over the years and the floods.

Recommendations of the National Forestry Office [ONF - Office National des Forêts] and the Regional Forest Ownership Centre [CRPF - Centre Régional de la Propriété Forestière]

The Regional Planning Directives and the Regional Planning Scheme for the low altitude Mediterranean zone of the National Forestry Office [ONF] require that "deciduous riparian forests [be] preserved as far as possible" during forestry operations and safety works, to "limit the impact of compulsory regulatory maintenance" and to "avoid clear felling on large areas or the planting of monospecific stands" [48], [49] whereas the Regional Forest Management Scheme of the Regional Forest Ownership Centre [CRPF] calls for caution in the management of riparian forests: favour non-intervention, refer to the Water Management and Development Scheme [SAGE] where it exists, perform moderate cutting [50].

The diversity of species and strata is increasingly high and interesting for biodiversity and for the soil in proportion as the riparian forest area is large. Indeed, the diversity of habitats is greater in large-sized woodlands. Some areas will be flooded more frequently than others, thus creating a mosaic of habitats. The width is therefore an important criterion. The study showed that bat activity significantly decreased when the width of the riparian forest was less than 40 m or 50 m with a deflection around 30 m.

However, when we give free space to the river, we often only consider the freedom of water to the detriment of the riparian forest which needs an additional buffer width to develop and maintain itself.

As for the watercourse, the management of the riparian forest must be carried out on a continuous functional scale, i.e. on the whole basin or by consistent sections in terms of functionality. The permanent continuity of these riparian woodlands should be a priority objective for watercourse managers.





33

Free evolution is practiced in the Tourtoulon wood, property of the Conservatoire du littoral [Coastal Conservation Authority] in Camargue [see the ONF forest management plan of 2004]

© Anthony Olivier - Tour du Valat - Riparian forest of Tourtoulon, Rhone river view [riverside poplar forest]

The functional width in other countries

In 1998, the Environmental agency of Great Britain defined the good functioning areas of watercourses ["corridor river"] as "land to either side of the channel, extending to the limits of associated floodplain wetland or at 50 m distance, whichever is the greater" [51]. More recently, Patricia Stoffyn-Egli and J.H. Martin Willison assessed the indispensable buffer width for species restricted to this land-water interface, taking the Beaver as an umbrella species. They estimated that "a review of riparian invertebrates, amphibians, reptiles, mammals, and birds indicates that a 50 m-wide buffer zone [measured from the high water mark] in its natural state [intact native vegetation] is the minimum area for supporting most of the riparian obligate species." [52].

Senescent riparian forests are the most favourable for biodiversity but they can also prove to be dangerous with the risk of falling trees and branches; this risk is increased by the fact that the species present are mostly softwoods, and that the trees can be destabilised during floods. Whereas it is important for the public to understand its environment in order to respect it, it is not necessarily judicious to encourage public access in the heart of riparian forests.



■ ASSESSING AND MONITORING THE EVOLUTION OF THE RIPARIAN FOREST

The QBR index, developed by Munné and his team [37] was tested by the Chauve-souris Auvergne association. It showed that the index responded rather well for rather heterogeneous banks (with or without vegetation): the banks with the best rankings also had the highest bat activity rates [53]. However, the QBR index was not relevant to our study since it does not take into account the fine variables of the woodlands, in particular those indicative of senescence. It is mainly based on variables characterising the riparian forests on the overall landscape scale. Given that in our protocol, the riparian forest pairs needed to have identical landscape characteristics (all wooded and with the same surface area) they had similar rankings. This index therefore does not necessarily enable a fine monitoring of the evolution of the riparian forest.

Besides the use of an index, monitoring the evolution of the forest can involve the surveillance of three main factors: the dead wood, the quantity of micro-habitats* and the presence of indicator species.

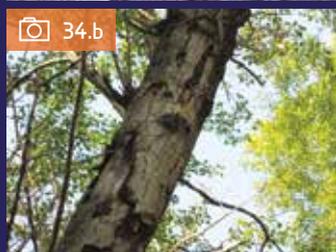


Fig. 34 Examples of micro-habitats: ivy (creeping) and cracks (Fig. 34.a); loose barks and microcavities (Fig. 34.b); woodpecker hole (macro-cavity) (Fig. 34.c)
© Fanny Albalat - GCP

The dead wood

It represents a source of shelters and food for insects and thus indirectly for insectivorous species such as bats. It contributes a great deal to the attractiveness of senescent forests. It is measured, according to the protocol of the ONF and the CRPF, in cubic metres [54], [55].

The micro-habitats (Fig. 34)

They represent potential roosts which determine the capacity for hosting certain arboreal species. To inventory the micro-habitats present in a plot, the observer must position himself near potential trees and observe the trunk and branches with binoculars in winter. It is important to do it before foliage, since 40% of the cavities can then be concealed (E. Cosson, pers. com.).

The bioindicator species

Some slightly more specialised species can indicate the functionality of the environment or the landscape. This is the case, for example, of **Bechstein's bat** which is strongly associated both with the continuity between forests and with the senescence of the woods [47], [56] or **Daubenton's bat**, used as a bioindicator in England (*Waterway Survey*) or in Spain (*QuiroRius*) [29]. It is therefore possible to monitor the evolution of activity patterns and the groups of species present.

■ A MANAGEMENT ADAPTED TO THE CONSTRAINTS

In actual fact, leaving a riparian forest in free evolution, and on several hectares, is a rare possibility. The riparian forest is often limited to a simple cordon, caught between a road, a field on one side and a calibrated watercourse on the other. Expansion possibilities are limited and safety issues are strong.

The first interest of riparian forests is not economic. But softwood is in high demand for some specific usages by paper makers or for packaging. The presence of water enables a rapid growth, so there are much greater volumes of wood than in dry forests. Silviculture should not jeopardise the functionality of the environment; when it is put in place, it should be in a very prudent manner (limited cutting, targeted and reduced removals, maintenance of a spacing factor* of less than 26 for example).

In some cases, surveillance is necessary, and cutting unavoidable, in particular in the context of security maintenance: pruning or felling trees that may become a dangerous log-jam or injure a rambler. There are currently many public access sites in riparian forests in the Southern region. In this case, a differentiated management is favoured between the heart of the plots (uneven-aged high forest management, even-aged high forest management on areas of several hectares, or management in old-growth islands depending on the contexts) and the sides of paths or settling points for the public (sanitation felling and emergency operations in case of windfalls*).

No cutting is insignificant, it must always be carefully thought through. To limit the impacts, one must be attentive to the timetable and the issues related or not to the tree. Riparian forests are potentially used year-round: the bats use them in the spring as hunting grounds and as roosts; once the young have fledged, the bats remain in this habitat for mating and migration;

in winter, some species hibernate in arboreal cavities (Lhu.7 (p.14)). The works affecting the trees must therefore take place in September-October, between the emancipation of the young bats and the fall into lethargy*.

When an unavoidable felling is performed outside the favourable period, an anti-return system* or soft felling* should be considered. These solutions are often costly and difficult to implement in emergency; they are not realistic in the case of a massive felling. It is then imperative to zone the issue parts and to respect the tight September-October timetable.

Finally, any roost-tree is potentially occupied since some bat species regularly change trees according to the weather, the predation risk and parasitism. In a forest, it is therefore not necessarily interesting to preserve the only roost-tree identified as really used: a set of roost-trees must be conserved for the habitat to remain functional.

In areas that are very constrained by developments, it is essential to conserve at least a wooded cordon on the edge of the watercourse, linking the various landscape structures.



3

**CONSERVATION
OF RIPARIAN FORESTS
TOWARDS AN EVOLUTION OF PRACTICES**



THE REALITIES OF RIPARIAN OF RIPARIAN FORESTS, feedback

The imperative to prevent flooding in the Durance river area translates locally into works on the vegetation [grubbing]. I work for EDF-HYDRO on defining works with the aim of best preserving biodiversity. A better environmental strategy would be to intervene much less, by reconsidering natural risks, giving more space to the river and riparian forests, allowing them to evolve naturally."

BASTIEN PASCAL— Ecologist engineer
EDF-HYDRO

The maintenance of small watercourses sometimes seems much like ditch maintenance; there are many stream stretches without a riparian forest or with a degraded riparian forest because recurring practices are used such as systematic crushing".

"When they maintain the riparian forest and the watercourse, most landowners reason on the scale of their property, without necessarily thinking about the consequences upstream or downstream."

AURÉLIEN TRANSON— Diffuse Pollution Officer
and **PASCAL BERBAIN** — River technician
Syndicat d'Aménagement du Bassin de l'Arc [Joint Planning
Association of the Arc Basin]

The riparian forest of the Sorgues area is cleared for the construction of buildings, roads and "soft mode" paths. It is subject to felling for fuelwood, disturbance of its wildlife and trampling by leisure practices, a drastic reduction of its width to optimise the farmland area. Invasive creepers cause the mortality of native species by coverage or suffocation."

SOPHIE LELIEVRE— Natural Areas
and Urban Planning Officer
Syndicat Mixte du Bassin des Sorgues [Joint Planning
Association of the Sorgues Basin]



3.1

THE LEGAL TOOLS



It is striking that no regulations identify the riparian forest as a legal subject matter, that no regulation specifically concerns it, whereas scientists and some codes insist on its economic importance for the services rendered, in particular ecological continuity and the good quality of watercourses. This absence is prejudicial and opens the way to all kinds of degradations.

Many laws and decrees can apply to riparian forests. This vast array of regulations is favoured by the particular place of these habitats, neither really water, nor completely land, subject to regular disturbance.

To illustrate this diversity, here are a few categories of legal tools concerning the riparian forest, classified according to the context:

- it contributes to the good functioning of watercourses: French Environmental Code, Framework Law on Water, legislation on water quality, Masterplans for Water Development and Management (SDAGE),
- it consists of woodland: French Forestry Code for land clearing and felling, French Town Planning Code for the classification as Classified Wooded Area* (EBC - Espace boisé classé) in the local town planning plans (PLU and PLUi), agricultural regulations for hedgerow management,
- it is commonly found on the edge of fields and contributes to limit the impact of phytosanitary treatments: French Rural and Maritime Fisheries Code, Common Agricultural Policy (CAP) conditionality,
- it can represent a danger for persons (falling trees, flooding): French Civil Code,
- it is part of our heritage and quality of life: Town Planning Code, Rural and Maritime Fisheries Code.

The absence of a precise and shared definition of the riparian forest increases the difficulty of identifying appropriate legal tools. Indeed, depending on the context (location, public or private owner, surface area concerned), it can be considered as a simple line of trees, a woodland, a wetland*, etc.

This plethora of legislations and their lack of precision lead to inadequate and ineffective measures. Hence, the legislation for felling in riparian forests is that of the French Forestry Code. The latter was created for large woodland areas, which is generally not the case of riparian forests.

Therefore, the surface thresholds making it compulsory to request permission for cutting are much too high when they are applied to riparian forests. For example, in the Alpes-de-Haute-Provence department, the Prefectoral Order enables cutting without authorisation at 2 ha. For a 20 m-wide riparian forest, one can therefore cut 1 km of forest without permission. This completely alters the riparian forests' role as corridors whereas it is recommended, for the Greater horseshoe bat, not to exceed a 38 m break in continuity [23]. This threshold is the lowest in the region, it can reach 10 ha in other departments.

Finally, even if a legislation were to theoretically enable the protection of a riparian forest, this would not prevent clear cutting by poorly-informed landowners. It is thus common to observe a posteriori the cutting of a protected riparian forest (for example under the PLU as an EBC* or even in a reserve). In this case, the police power is not always easy to apply either for lack of means, or due to a conflict of interest. However, in the light of the recent dramatic cuttings in riparian forests in the Drôme and neighbouring departments by clever farmers, a prefectoral regulation specific to riparian woodland is becoming a necessity.

The survey conducted as part of the RipiMed study to identify the riparian forest management tools enabled a non-exhaustive list of a wide variety of legal tools concerning them to be drawn up. The most used tools are the listing as Classified Wooded Area* (EBC - Espace Boisé Classé) and the Natura 2000 network.

ARTICLE	PRINCIPLE
FRENCH ENVIRONMENTAL CODE	
L132-3	Establishment of a Real Environmental Obligation*, either voluntary or related to "Avoid Reduce Compensate" measures.
L211-14	Maintenance of a 5 m-wide grassy/treed strip along classified watercourses*
L212-5-2	Third-party effectiveness of the SAGE regulation for watercourses that have one
L215-14	Obligation for the owner of lands adjoining a river to maintain the banks with no details on the management terms and limits
L350-3	Protection of tree alleys and lines of trees along communication routes
L414-1 et seq.	Principle and creation of Natura 2000 areas
R411-15	Principle and creation of Prefectoral Orders for the Protection of Biotopes
L562-1 et seq.	Plan for flood risk prevention
L211-12	Public utility easement
L215-4	Restoration after modification of the riverbed by a flood (1 year time limit)
FRENCH FORESTRY CODE	
L124-5	No requirement for authorisation for clear cutting below a threshold set by a prefectoral order
L124-5	Threshold of 0.5 ha for riparian forests in the Vaucluse department (draft measure)
L341-3	Ban on land clearing (land-use change) without authorisation
L411-1	Classification into protection forest for ecological or safety reasons



ARTICLE	PRINCIPLE
FRENCH RURAL AND MARITIME FISHERIES CODE	
D.615-46	Maintenance of a 5 m-wide grassy/treed strip on the edge of fields to receive CAP subsidies
L126-3	Prefectoral protection of linear woodland, hedgerows and trees planted in lines, either existing or to be created
FRENCH TOWN PLANNING CODE	
L113-1 et seq.	Ban on clearing of Classified Wooded Areas* (EBC), tree cutting subject to a simple declaration
L151-18	Establishment of rules favouring the blending of buildings with their environment (conditions of alignment on the roadway, minimum distance from the dividing line, development of their surrounding area)
L151-19	Entry in the sites regulation for reasons of cultural, historical, or architectural order
L151-23	Identification and localisation of elements and sites to be protected in particular for the maintenance or restoration of ecological continuity
L151-6 et seq.	Principle and creation of the Development and Programming Guidelines allowing for the establishment of rules in certain issue areas

OTHER LEGISLATIVE AND REGULATORY TEXTS	
Ministerial Decree of 23 April 2007 listing the terrestrial mammals protected throughout the country and the terms of their protection	Strict protection of Chiropterans and their habitats
Ministerial Decree of 19 December 2018 listing the natural habitats that may be the subject of a prefectoral order for protection of natural habitats in metropolitan France	Protection by prefectoral order of habitats including <i>Salix alba</i> and <i>Populus alba</i> gallery forests and <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> alluvial forests
Prefectoral Order No. 05-2017-03-06-001 of 06 March 2017	Maximum threshold of 4 ha for clear cutting in woodland that is not subject to a management plan in the Hautes-Alpes department
Prefectoral Order No. 2005-3081 of 25 November 2005	Threshold of 2 ha in the Alpes de Haute-Provence department
Prefectoral Order No. 2015-403 of 01 June 2015	Threshold of 10 ha in the Alpes-Maritimes department
Prefectoral Order No. 235 of 10 June 2013	Threshold of 10 ha in the Var department
Prefectoral Order No. SI2011-05-06-0040-DDT of 16 May 2011	Threshold of 4 ha in the Vaucluse department
Prefectoral Order No. 2014157-0002 of 06 June 2014	Maintenance of a 10 m-wide grassy/treed strip in vulnerable zones identified under the Nitrate Directive
Rural development regulation	CAP subsidies that may concern hedgerows and woodland
MAEC LINEA03 - Maintenance of riparian forests	Specific CAP subsidy for the maintenance of riparian forests

3.2

THE FACTSHEETS



The following factsheets do not aim to draw up an exhaustive list of all the tools available because there are so many of them. They address the main avenues that emerged from the discussions that took place during the course of the study and in the 10 working groups organised in 2019 with the partners and stakeholders who agreed to participate.

The subject of riparian forest conservation seems relatively recent and has yet to be fully explored through the setting up of working groups and awareness-raising approaches. Effective actions can only be established thanks to the feedback and communication between stakeholders.

The following factsheets therefore address the issues related to the various subjects and associated problems, and present a first solution one should strive toward and the other possible approaches.

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Riparian forest on the Natuby river,
Var © Alain Abba

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Land clearing & cutting

Observed cutting
on the territory of the Grand Site
Sainte-Victoire during the study
© Lorenza Buono – GCP

■ THE ISSUES

As we have seen, riparian forests represent less than 1.6 % [57] of the Southern region's territory. They concentrate however a large number of functions that are useful to ecosystems and therefore to Man. Like watercourses, riparian forests irrigate landscapes and ecosystems.

■ THE PROBLEM

Clear cutting for timber exploitation is not officially land clearing* [land-use change]. Given the very dynamic regrowth in riparian forests, the regeneration - as required after cutting in the decrees associated to Article L124-5 of the French Forestry Code - is very fast, but compliance with this commitment must be ensured and the cases where it is concealed land clearing should be identified.

Riparian woodlands can be affected by direct and aggressive destructions in the case of clear cutting or discreet or chronic whittling

away as a result of urban, industrial or agricultural expansion. Sometimes, the cutting is observed only in retrospect 36 or the whittling away is too discreet to be detected. These operations can lead to a localised loss of functionality, either temporary [according to the resilience* of the functional role and the species affected] or definitive, if it is related to a land-use change [road, crop, ZAC [zone d'aménagement concerté - designated development area],...] and thus prevent the riparian forests from fulfilling their functional roles.

■ THE PREFERRED SOLUTIONS

No unique solution since the sources of cutting or land clearing* and their administrative processes are multiple. It is therefore important to understand the factors leading to it: land development, creation of a hydroelectric plant or a dike, silviculture, tourism, agriculture or watercourse restoration. In some cases, the justifications are unclear and the one-off and cumulated impacts are underestimated.

Four complementary lines of action can be considered in order to limit this cutting and land clearing*:

➤ defining and mapping the riparian forests: propose a definition of the riparian forest [tree species, soil hygrometry, width,...] and map it to target and adapt the management and the legislation to the localised and identified issue,



- **adapting the legislation to riparian forests:** it becomes necessary to have specific tools such as, for example, lowering the minimum area at which cutting requires a permission, by supplementing it with other restrictions (width),
- **raising awareness:** it is important to make the roles and fragilities of the riparian forest known both to the planners and the general public; elected representatives have a central role to play to include long-term ecological restoration in the decisions concerning the future of the territories,
- **implementing an integrated management:** associate the management players and the civil society to collectively establish a concerted overall management plan for the riparian forest and watercourses with a clear objective to be achieved in the form of an ecological reference status of restoration. The action priorities will then emerge when comparing the initial state with the target reference status. In addition, when the various ruling players (Prefect, DDT, mayor, etc.) work in cooperation, simple reminders of the law with controls can be sufficient to prevent destructions. Finally, the Good Functioning Space of watercourses encouraged by the SDAGE [58] is a tool which could accompany the concerted action by facilitating positive interactions between the water development and management players and those of the land, with a common objective.

Property is often very fragmented for riparian forests, each one being below the thresholds requiring authorisation for cutting. Groups of owners can be envisaged to establish a consistent forest management plan in a significant part or the whole of a riparian forest and prevent uncontrolled cutting.

Finally, the Ministerial Decree of 19 December 2018 listing the natural habitats that can be the subject of a prefectural order for protection of natural habitats in metropolitan France can serve as a specific framework for forest exploitation in riparian forests (maintenance of the trees, density and removal thresholds) or their inclusion in the PLU(i) (limiting developments, adapting management practices, protecting delineated sections).



**JULIE LARGUIER— Development and Biodiversity Project Manager
Grand Site Sainte-Victoire, Aix-Marseilles-Provence Metropolis**

" Among the 3 watercourses of the Grand Site Sainte-Victoire studied as part of the RipiMed programme, we note the temporary nature of 2 of them: the Bayon at the south of Sainte-Victoire and the Cause in the valley of Vauvenargues. As for the Réal stream, urbanisation on each of its banks from the village of Jouques to its confluence with the Durance river should be noted. The maintenance of the watercourses' riparian forest remains the responsibility of the riverside landowners. Since the surveillance of these riparian forests is sometimes made difficult (private properties, private access...), their degradation on small sections, leading to habitat fragmentation, has sometimes been noticed in retrospect. It therefore seems appropriate to raise the awareness of the riverside landowners about the issues related to this habitat at the ecosystem level.

Besides the opportunity to improve knowledge on the use of the territory's riparian forests by bats, and the role of the maturity of these forests in the conservation of Chiroperans, this study could make it possible to raise landowners' awareness in a more practical way and to develop with basin associations a communication partnership on the maintenance of these riparian forests in order to prevent clear cutting (dissemination of a good practice guide for landowners: objectives, techniques and consequences of a maintenance that is compliant with the risk protection measures and respectful of the ecological issues, grass-roots projects and support by municipalities, teaching initiatives,...). All this remains to be co-built."



The dikes & floods

📷 37

Diked watercourse
© Fanny Albalat - GCP

■ THE ISSUES

The riparian forests, which are preferred transit routes, have developed on the dikes left without maintenance for several decades and have sometimes become beautiful woodlands [59]. These ancient forests are a much more important ecological asset than the young ones owing to the presence of roost trees and standing and fallen dead wood. They are often the last woodlands on the edge of watercourses that have undergone a severe impoundment and a reduction in wooded areas at the back-dike level.

■ THE PROBLEM

According to the general recommendations for dikes, no woody vegetation should be present on the structure. There is a risk related to uprooting or root rotting which generates weak spots in the dikes [60], [61]. When an old wood has developed on a dike, there is a real conflict between its functional value for the environment and

the safety of property and people from flooding. Finally, riparian forests that develop on the structures, particularly in urban environments, are a strong asset for the inhabitants whose quality of life is increased (landscape, coolness islands, leisure) but also represent a risk. These antagonisms are difficult to resolve.

■ THE PREFERRED SOLUTIONS

Dikes were created in order to protect humans from flood-related risks. It is important to precisely assess the level of security of a dike: the substrate with which it was built, its compaction level, its resilience* to windfalls and root rot, etc., should be known. We observe oversight of the flood-related risk among riverside communities and decision-makers, especially with the presence of dikes. Despite the significant cost of their construction and maintenance [62], the recent events show their faillibility: the breaches can sometimes cause more damage than the unconstrained flood. Lastly, dikes are often on the edge of the minor riverbed, leaving little possibility for the river to flow freely and extend, increasing the speed of water flows and limiting the presence of woodland.

It is more interesting to dismiss as much as possible the human issues and the dikes of the medium riverbed and to favour the Good Functioning Space (see Water Agency Guide, June 2018) which facilitates the development of riparian forests. In general, the limiting factor* is the available land; the two important tools will therefore be land control* or cooperation between land planners and managers.



■ ALTERNATIVE SOLUTIONS

In actual fact, urban expansion leaves managers with little choice. Flood protection, ecological and landscape value must be simultaneously reconciled in an area that is too small. In the case of very ancient and very vegetated dikes, rather than modifying everything, it is possible to open certain portions to enable the water to run into floodplains, or to build a new dike by moving it away from the bank [dike retreat]. The floodplains can then be dedicated to the development of riparian woodlands.

When the dike is in a good state, it is possible to keep some trees while monitoring and minimising the risks. This requires diagnosing the safety issues and ecological issues. The management will then be adaptable per section: tree density, selective cutting, pruning, brushwood clearing. It is also possible to leave trees at the foot of the dike on the watercourse side when uprooting risks are limited [case of slow onset floods] [60], [61]. Finally, as a last resort, when the continuity is at risk of being severely altered, a dry wood can be planted on the land side to avoid too large openings.

The projects that leave vegetation on the dikes require a strong position to be taken by the managers and State representatives; they must be thought out with all the related issues, in particular human ones: adaptation of the buildings, evacuation exercises, risk culture [63], [64]. Indeed, the slightest accident is the responsibility of the manager and might lead to a new tightening of the regulations for population protection after the Decree No. 2015-526 of 12 May 2016 relating to the rules applicable to the structures built or developed to prevent flooding and to the security rules for hydraulic structures.

3

In the words of...



FULVIO E. CARONNI— Vegetation and Forests Sector
Tessin Park, Lombardy, Italy

" The true large defence operations against the Tessin river floods are led by the Territorial Coordination Plan (PTC) and the Hydrogeological Planning Plan (PAI), which prevented the construction of buildings and infrastructure in flood-risk areas. On some sections, ancient houses or old structures were sometimes built before the entry into force of the PTC and the PAI. In these situations, it is possible to intervene locally in order to defend these buildings against flooding. In the areas that have benefited from these protection operations but are now abandoned, the presence of the defence structures had become pointless. They were therefore demolished, which enabled the Tessin river to return to its initial course. If the flood concerns woodland or areas with no human concern, we let it happen. This sometimes generates controversy, in particular when wooded areas are destroyed, but we respond to them by explaining that these phenomena are an integral part of rivers' natural dynamics and that trying to prevent them by building large defensive structures would cost much more and would cause much more significant damage.

In 1980, with the approval of the Territorial Plan, gravel quarries exploiting the minor riverbed of the Tessin river were closed [there were then 18 active quarries, extracting more than a million cubic metres per year]. Since then, a re-balancing of the hydrographic network, which is still underway, began and enabled the riverbed to be stabilised. Today, 2 critical points remain to be resolved: the foot of the Vigevano bridge and the "bridge of boats" of Bereguardo."



Urban planning and public access to riparian forests

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The Petit Rhône river
© Fanny Albalat - GCP

■ THE ISSUES

The riparian forests are special and important habitats for biodiversity at a territory level. These areas also play many ecosystem roles [5 p. 10-11]. All the functions they endorse, which indirectly maintain our well-being, our social ties and our economies [65]-[67], give them legitimacy to be fully integrated into large-scale land-use planning.

■ THE PROBLEM

The needs for urban sprawl are constantly on the increase but the available area is increasingly limited: wastelands, farmland, natural areas. Moreover, whereas nature in towns is an important subject for the well-being of inhabitants, naturality is sometimes a source of fear [p. 9] and abuse [waste disposal]. The safety-related maintenance for public access prevents the forest

from ageing naturally [removal of ageing or dead trees]. Lastly, enhancing the woodland sometimes entails the installation of lighting which then produces light pollution affecting the lucifugous* species. The willingness to enhance riparian forests should not jeopardise their functionality and their role in our socio-ecological system* [67].

■ THE PREFERRED SOLUTIONS

The PLU(i) is a tool which enables the issues to be considered on a fine scale. Taking riparian forests into account in these plans requires the knowledge of what they are and of all the related issues [training or support during the preparation of the PLU(i)]. This makes it possible to include them effectively in the mapping and guidelines for their conservation and then to be alert to any degradation and respond to it. For this, there are tools:

➤ the classification as **Classified Wooded Area*** [EBC - Espace Boisé Classé]: this tool commonly used for riparian forest conservation enables the classification of trees and woodland, either existing or to be created, in order to prohibit "any change in land-use or land cover which might jeopardise the conservation, protection or creation of woodland" [Article L.113-2 of the French Town Planning Code]. Cutting remains possible and subject to declaration, it is therefore important to remain alert to the management practices considered in these areas. It is not however a tool that protects the wooded state or the particular nature of the woodland [maintenance of large-sized trees, of a continuity, etc.]. In dealing with offenders, it is only rarely applied by the mayors responsible for it. It therefore remains insufficient.



➤ the **Development and Programming Guidelines (OAP - Orientations d'Aménagement et de Programmation)**: they "define the actions and operations necessary to enhance the environment, in particular ecological continuity". The works undertaken in the areas concerned must be compatible with the guidelines and possible timeframes considered. This remains a general guideline and not a requirement. Its effectiveness remains to be demonstrated. It is a more flexible tool than the classification as EBC* or the inclusion in the regulation presented below.

➤ the **PLU(i) regulation**: it determines the rules that become "enforceable against any public or private person or entity for the execution of any works" (L123-5 of the French Town Planning Code). The riparian forests can then be classified under heritage (L151-19 of the Town Planning Code) or the environment (L151-23 of the T.P. Code)

■ ALTERNATIVE SOLUTIONS

What can be a constraint can easily become added value at the municipality level (naturalness, well-being, heritage) and of public utility at the level of a territory (self-purification of pollution, water reserve, flood expansion).

The preservation is not undertaken only by constraint or repression which are in any case cumbersome to implement and apply. It also involves the enhancement of these habitats through the water or river festival, or events organised at schools. Nevertheless, this enhancement should not be carried out through public accessibility to the heart of the woodlands. Indeed, the most interesting riparian forests for the ecosystem are the senescent ones with cavity trees and/or dead trees, often on the outer edge of the woodland, likely to represent a safety hazard for ramblers. The paths penetrating into the heart of riparian forests should therefore be exceptional, the visitors should be warned, and the paths should be restricted from use in case of bad weather; these forests should be seen as essential allies of our well-being and our heritage without however being a leisure area.



GUY MOUREAU— President of the **Syndicat Mixte du Bassin des Sorgues (SMBS - Joint Association of the Sorgues Basin)**

" Since 2012, the SMBS has been carrying out the task of advising the municipalities for including the riparian forest preservation issues in their country planning documents. It participates in the consultation meetings on 15 PLUs (local town planning plans) and 2 SCOTs (territorial coherence schemes), and issues a reasoned opinion of its Association Committee on the country planning documents. Our recommendations which are already translated in graphic layouts, OAPs (planning and programming guidelines) and regulations of the country planning documents are: the use of Article L 151-23 of the French Town Planning Code (elements to be protected for ecological reasons), the maintenance and development of EBCs*, the setting up of setback margins for buildings, the setting up of sub-sectors indexed as "ecological corridor", the rewriting of easements for rights of way and river maintenance, more protective of woodland.

Through the successive revisions of the country planning documents, the SMBS has gained legitimacy. We also consider recommending the setting up of spaces reserved for ecological continuity and non-imperious or eco-developable surfaces. Some questions remain sensitive and limit our position statements: what "threshold" width of riparian forest for a good functionality of riparian environments? What riparian forest width is the local authority willing to preserve according to the areas (urbanised, to be urbanised, agricultural, natural)? How to support farmers for the regeneration of riparian vegetation not to take place at the expense of their production tool?"



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Agriculture

Lesser horseshoe bat while foraging
© Tanguy Stoecklé

■ THE ISSUES

Riparian forests can be a real asset for farmers. According to the type of crop, they can serve as a windbreak, be a source of coolness, and favour water infiltration into the ground. They enable a better maintenance of the banks, and are purification buffer areas. They finally have an ecological interest which makes it possible to rely on crop auxiliary species, in particular bats.

■ THE PROBLEM

Riparian forests are rarely perceived as an advantage in the agricultural community. On the one hand, they are seen as competing with crops for the consumption of water and soil resources and as a constraint for the physical maintenance of the lands [handling of agricultural machines]. On the other hand, the regulations related to the Common Agricultural Policy (CAP) subsidies are rather cumbersome: area constraint, maintenance constraint. They can be considered as a hedgerow, a line of trees, or a grove according to the criteria, each one having different obligations [maximum tree density to be observed, ban on hedgerow cutting, etc.] [68]. There is therefore no unique status for riparian woodlands in the context of an agricultural issue, which hinders the issues from being correctly taken into account.

When the woodland is too large to fall within one of the preceding categories and too dense to be considered as agroforestry (>100 trees /ha), it may possibly fall under the aid "Investments in the development of forest areas and improvement of forest viability" which, however, does not seem to be very developed in the Southern region. Any area recovered by felling or infilling* might then no longer be exploitable through farming and the associated CAP subsidies.

We sometimes observe, after a reduction in the width for agricultural expansion, the setting up of an earthen bund* (barrier of earth) in place of the riparian forest (to limit the natural flood expansions) leading to a strong artificialisation and the formation of a ditch in place of the river. Finally, the riverbanks often belong to several farmers who, according to the size of the plots, must work together for a consistent conservation or restoration of the riparian forest, which is a major disincentive.

■ THE PREFERRED SOLUTIONS

The negative aspects described above are immediate and observable; the benefits of maintaining a riparian woodland at the farm level are less visible in the short term. Therefore, the conservation and restoration of riparian forests can be encouraged only through the maintenance and dissemination of knowledge about the roles they play and upon which farmers can rely.



■ ALTERNATIVE SOLUTIONS

The farmers suffer from substantial payment delays for their biodiversity preservation actions on their farm: 15 % of the 2016 CAP subsidies (in particular the subsidies of the second pillar including Agri-Environmental and Climate Measures [AECM] and support for organic farming) and 38 % of the 2017 subsidies have still not been paid in 2019^[69]. Moreover, the presence or absence of riparian forests on farms can directly affect farmers by requiring additional maintenance; such constraints may lead to decreased payments (share of Areas of Ecological Interest, AECM, etc.) or to the will to clearcut them. It is also necessary to clarify its status in the agricultural policy and the rural code and to better integrate riparian forests in the CAP payments.

There is an AECM dedicated to riparian forests, but it does not seem to be attractive or effective in the Southern region for environmental conservation and restoration objectives. It requires ongoing maintenance, which does not favour the ageing of woodlands; it is indemnified per linear metre which does not encourage development in width.

There are other measures in favour of woodland, in particular Article 22 of the Rural Development Regulation "Afforestation and creation of woodland" or Article 25 "Investments improving the resilience* and environmental value of forest ecosystems". It could be suggested that restoration by free evolution and the dedicated area should be put to more effective use.



AURÉLIEN TRANSON— Diffuse Pollution Officer
and PASCAL BERBAIN — River technician
Syndicat d'Aménagement du Bassin de l'Arc
[Arc Basin Planning Association]

" On the border of agricultural plots, the riparian forest is often absent or degraded because systematic practices such as total crushing are used, which does not guarantee any of the natural functions of the riparian forest. Preserving and regaining the diversity of the riparian forest necessarily entails reasoned maintenance. It is because of this concern with the restoration of a functional riparian forest that the Arc Basin Planning Association (SABA) supports volunteer farmers of the river basin on two pilot sites. This support consists in the implementation of an adapted and differentiated maintenance of the riparian forest on two stretches of tributaries on the border of agricultural plots, a regular site monitoring, and strengthened advice to these farmers.

The first site corresponds to an inexistent riparian forest on the edge of vineyard plots. The aim here is to leave room for the vegetation to develop naturally through non-intervention on a strip of 1,5 times the width of the minor river bed. On the second site, where the riparian forest diversity is threatened by an invasion of brambles, the maintenance works consisted in selective cutting to preserve the young shoots of trees, and the planting and seeding of local species that are adapted to compete with the brambles.

This action in partnership with the farmers, enables the SABA to have feedback on the rewilding of the riparian forest (costs, maintenance time, benefits and constraints with respect to the change in practices, ...). Through this collected information, in addition to the field education, the SABA hopes to prompt initiatives for regaining the riparian forest and appropriate management practices."



Restoration & compensation

📷 40

© Archive photo
Tessin Park

■ THE ISSUES

Ecological restoration of riparian forests has become indispensable for a sustainable development. It rehabilitates the ecosystem services and functions lost following the degradation or even the complete disappearance of riparian woodlands.

■ THE PROBLEM

Riparian forest restoration projects need to be stepped up. They require a true political will over the long term as well as appropriate legal tools and effective cooperation between the various stakeholders.

■ THE PREFERRED SOLUTIONS

Ecological restoration can be carried out over long time steps and must include the human factor and human activities in order to be lasting and successful. The actions to be carried out depend on the reference status defined and the functions sought. The reference status to be attained is not necessarily related to a historical status but rather to an "ideal" ecological status to be achieved. It must be decided collectively.

■ A RESTORATION EXAMPLE: the Tessin river's riparian forest, Italy

The Tessin Park in Lombardy, Italy, covers the downstream part of the Tessin river, which is the main tributary of the Po river, as well as its alluvial forest, and engaged in steps towards the restoration of the latter, several decades ago. Since the 1940s, the Po Plain has been subject to very strong human pressure [urbanisation, industrialisation, intensive agriculture...] which has contributed to the near disappearance of its forest heritage apart from historical hunting reserves making up the riparian forest. The local communities have remained attached to these woodlands, which favoured the creation of the park in 1974. This, together with the emergence

of the first regional forest laws, helped to stem this decline and rehabilitate the Tessin riparian forest.

The park first undertook a census of the remaining forest heritage and guided its management through a "forest management plan" subject to Natura 2000 impact assessment. It defines a frame of reference aiming to qualitatively and quantitatively safeguard the forest resources, by enabling a reasoned exploitation. Since 2008, it also contributes to urban planning and can, moreover, define the areas where compensation measures are to be applied.



The Park then launched actions to restore the Tessin river's riparian forest. These actions no longer aim only to produce timber but also to be a source of new forms of richness for the local community: strengthening the ecological corridor formed by the riparian woodland of the Tessin river; maintaining the buffer area role played by the riparian forest and the hydraulic annexes; maintaining the security of property and people with respect to flood risk. The Park also seeks to control the lands: more than 1200 ha have been acquired in 40 years with funds coming from compensation, but also from the Region, the State, donations or European programmes such as LIFE.

Currently, we can clearly say that the project for rehabilitation of the Tessin river's alluvial forest is a success. The watercourse and its riparian forest form the last functional ecological corridor linking the Apennines to the Alps, i.e. continental Europe to the Mediterranean basin in Italy. The minor riverbed is not constrained, the linear woodland is not or little fragmented. On each bank, the riparian forest is on average several hundred metres wide, up to 1 km, and hosts a remarkable biodiversity, especially in Chiropterans with a colony of 4000 lactating females of Geoffroy's bat!

■ COMPENSATION, a restoration ally?

Apart from a few rare privileged areas, the riparian forests are already very constrained. Along with the conservation of existing woodlands, the restoration of riparian forests remains an essential way of conserving or restoring the functionality of this habitat which should be planned at the landscape level. Widening the riparian forest and reconnecting it to the neighbouring forests are projects which could be part of a compensatory approach. For the restoration approach to be consistent and the compensation effective, it must be planned on the whole territory. It must be organised through a supervising compensation organisation with a comprehensive view (for instance, an EPCI on the whole river basin). The implementation of a land acquisition strategy can then be considered according to the mapping of expansion areas and green belts* to be restored.

However, the doctrine for applying compensation must be discussed. In the current implementation of compensation, priority must be given to the same habitats as those destroyed. In other words, to compensate for the riparian forest, it should be partly destroyed! Given the issues surrounding this natural habitat and the area it covers on a regional scale, that is not acceptable. Compensation, or facilitating its application, should not favour the destruction of the riparian forest.

OLIVIA MAGNOUX— GEMAPI* Mission Head
Communauté de Communes Coeur du Var
[Community of Communes of the heart of the Var department]

"The first programme for restoration and maintenance of the Riartord river and its tributaries took place from 2013 to 2017. The works had three objectives, namely the restoration and maintenance of the riverbed and banks, flood prevention and enhancement of the habitats and heritage.

The ecological rewilding of the banks consisted in regenerating the riparian forest through planting often combined with softening of the banks. These works carried out with the consent of the landowners were very well received. Indeed, the enhancement of the watercourse through the regeneration of the riparian forest enables the landowners to reappropriate this landscape element. In addition, some of these works were carried out in agricultural areas with the removal of dikes. This project was carried out with the consent of the farmer who noticed a difficulty for the water to recede from his plots following the flood of 2010. On the other hand, it should be noted that the regeneration of the riparian forest is more difficult to implement on sections that are close to houses. Indeed, softening the banks makes the houses more vulnerable to floods."

In the words of...



Awareness-raising & transversality as a conservation approach

📷 41

" Dans les Bras du Rhône "
[In the Arms of the Rhone River]
CPIE Arles © Yann Lecouviour

■ AWARENESS-RAISING OF THE GENERAL PUBLIC

Raising awareness among the general public should not be overlooked, especially since, as we have previously seen, the riparian forest has a heritage interest that can be shared by all. There is a growing awareness of the necessity to protect nature, in particular due to the impacts of climate change felt in our daily lives. It is important to engage in this dynamic which is accelerating to meet the expectations of the general public; the latter may also act more broadly for better consideration of alluvial forests and thereby participate in their protection.

In environmental education, it is a well known fact that "we protect better what we know."

Awareness-raising actions for the public at large are already led by associations such as the French Permanent Centres for Environmental Initiatives (CPIE - Centres Permanents d'Initiatives pour l'Environnement), the Conservatories of Natural Areas (CEN - Conservatoires d'espaces naturels), by public players such as the Departments [schemes related to Sensitive Natural Areas] or indirectly by the Water Agencies which fund this type of action, for instance through river contracts.

Many tools have already been deployed.

Exhibitions [such as that initiated by the CEN PACA in 2018 "Wetlands*, an invaluable and irreplaceable heritage to be preserved"], conferences, educational material for the school public, educational kits, nature discovery through collective outings run by a professional, educational and interpretation paths, guide for riverside residents ["guide du riverain"] by the watercourse managers, Participative Science programmes on biodiversity [70], water festivals, etc.

This awareness-raising must be thought out and organised since the goal is not to encourage and facilitate access to all the riparian forests as a leisure place.

In the words of...

DANIEL MADELEINE—President of the association La Cistude

"Our association La Cistude [...] intervenes in a very rich area composed of wetlands, migration corridors for several species (more than 174 species of sedentary or migratory birds identified). Each year, La Cistude organises several awareness-raising events: World Wetland Days (JMZH - Journées Mondiales des Zones Humides), Spring of the Beavers (Printemps des Castors), Day of the Night (Jour de la Nuit), Durance River Classes, etc.

Conferences, exhibitions, and nature outings reach all audiences and events are reserved for schoolchildren. At the JMZH this year, particular attention was drawn to the protection of Chiropterans. For example, with the help of several partners, we have installed 3 roosts and this year we reached 370 people, all audiences combined, with construction workshops and advice on roost installation for private individuals."

ASTRID ABEL—Southern Rhone Mission Head
Centre Permanent d'Initiatives pour l'Environnement (CPIE - Permanent Centre for Environmental Initiatives) Rhône Pays d'Arles

"This event for the general public, "Dans les Bras du Rhône" [In the arms of the river Rhone], is part of the continuous activities run by a Southern Rhone network of players. It also results from the DROEP, an educative scheme on the river developed under the Rhone Plan between 2012 and 2015, one of the conclusions of which is the necessity to keep river alive, to make it known to the general public and celebrate it. This annual event, created in 2017, aims to federate a maximum number of organisations around the issues of the river Rhone and to share knowledge, relying in addition on the research and expertise of local players, and to be permanently anchored in the territory. This takes different forms: visits, navigations, exhibitions, cine-debate, etc., around the formation of groups of two or three players, combining scientific, naturalistic and artistic approaches. During this event, the visits take place on the banks of the Rhone river in partnership with the Symadrem in order to explain the protection role of dikes. Canoe trips on the river, accompanied by naturalist* guides, make it possible to observe the biological diversity along the banks of the Rhone and to address the issues for the protection of these habitats  41."

CHRISTOPHE GARRONE— Research engineer
Maison régionale de l'eau (MRE)

"The MRE raises awareness and educates on the theme of water and aquatic environments. Its aim is to provide or help gain knowledge to improve the skills of the audiences on issues relating to water and rivers, to better understand the issues around the management of aquatic environments and promote a drought or flood risk culture. [...] The riparian forest is one of the lines of action of the MRE through days of exchange, application development, and information stands for the general public. These discussions enable us to get a first idea of the perception of the riparian forest. [...] It is not new, the many functions associated with the riparian forest are known and recognised by many professions: hydromorphologists, ecologists, managers, hydrobiologists, etc. However, this perception is not always shared and is sometimes even quite far from the many services that can be rendered by the riparian forest.



■ AWARENESS-RAISING OF THE STAKEHOLDERS

Over the ten workshops that punctuated the RipiMed study in 2019, the need for awareness-raising of all the players involved directly or indirectly in the management of the watercourses and the riparian forest was strongly expressed. Lack of knowledge about the issues results in taking decisions that overlook the riparian forest. Raising the awareness of decision-makers would make it possible to prompt a real political will for better consideration of riparian forests, to decide on a precise framework and on legislative tools specific to riparian forests.

The management of the riparian forest and its watercourse concerns multiple players: elected representatives, managers, private owners, farmers, consultancy firms, architects, State services. An integrated management method, which is to be encouraged, is based on a participative approach where all the stakeholders must be able to express themselves and decide collectively [71]. Raising the awareness of all the stakeholders in the first phases of a project is essential. Starting from a same level of knowledge, the decision-making is more relevant. The difficulty related to the lack of mobilisation of all the stakeholders can sometimes hinder this type of management.

All these approaches also entail improving the scientific and naturalistic knowledge about riparian forests, which attract today only very little research and attention.

00 CÉLIA GRILLAS—Natura 2000 Project Coordinator
Regional Nature Park of Camargue
(PNRC - Parc naturel régional de Camargue)

" The river Rhone's riparian forest essentially takes the form of a narrow linear woodland, limited by agriculture on one side and the river Rhone developments on the other. Despite its degradation, it is a habitat of great importance for many species. The river Rhone's riparian forest currently continues to suffer from cutting, which is threatening its already highly altered functionality. In 2018, 4 clearcuts were observed in these riparian woodlands. These observations, made in an opportunistic manner, very likely underestimate the reality. They raised however several problems: a lack of regulatory protection of these habitats and a lack of knowledge about the regulations on the part of the forest owners; a lack of awareness of forest owners with respect to the issues for the conservation of this habitat; an increasing pressure on the timber resource through the development of the wood-energy sector.

The PNRC is the coordinator of the Natura 2000 sites "Petit Rhône" (Small Rhone) and "Rhône Aval" (Downstream Rhone) For these sites, the preservation of the riparian woodland is a priority. For this reason, and subject to funding, the PNRC wishes to engage in an effort to raise awareness and communicate to forest owners in order to prevent future cuttings in riparian forests. A project combining awareness-raising operations and restoration operations is currently being developed in partnership with the Regional Centres of Forest Property (CRPF) of PACA and Occitanie".

In the words of...



Awareness-raising is an essential approach for a better appropriation of the knowledge about environmental protection issues. It leads to greater awareness, which is the starting point of real behavioural changes.

The massive deployment of this approach would be supported by an increase in the human and functional resources of the leading organisations. This is not yet the case today.



The RipiMed study leads us to two main findings: a positive assessment with the confirmation of the central role of riparian woodlands, especially senescent woodlands, for Chiropterans and, by extension, for wildlife in general; and a mixed assessment for the current management and consideration of riparian forests in land-use planning.

What should we learn from this study?

- all the local species use the riparian forest; the very high biological value of senescent riparian forests was highlighted with 3,7 times more overall activity than in young riparian forests,
- many roosts which appear earlier than in dry forests, 3 times more potential roosts per tree in senescent riparian forests than in young ones,
- a major trophic resource, 7 times more gross hunting activity in senescent riparian forests than in young ones,
- central ecological continuity; even the young and thin riparian forests remain essential ecological continuities.
- a social role for bats, the riparian forests are the place of autumn display for some species,
- the functional width of riparian forests is between 30-50 m according to the species.

The longitudinal continuity is to be absolutely maintained, this observation is not new; the bibliography shows the absolute necessity of continuous ecological networks for most Chiroptera species. For example, a negative effect on the Lesser horseshoe bat could occur from 10 m of cutting [Tillon pers. comm.]. Transversal continuity, from the river to the forests, also seems essential for several species. The study results indicate that Bechstein's bat, a demanding forest species, might be present only in riparian forests connected by woodland to forests. Thus, the loss of connectivity has a large-scale effect; whole territories can be made inaccessible for sensitive species.

Finally, recent research in the Mediterranean has shown that riparian forests are key habitats for the survival of Chiropterans in drought periods. This fact draws our attention to global warning and its consequences.

What solutions exist?

It is now a known fact that riparian forests are of very great value for bats which are taken here as indicative of the issues, they are therefore species habitats within the meaning of the Ministerial Decree of 2007. They must be subject to high vigilance during developments, trigger ARC measures and derogations concerning protected species. What we destroy always seems negligible and the cumulated affects are rarely considered. The preservation and especially the restoration of these natural habitats must be a priority in the years to come for decision-makers, river managers and the civil society.

We call for strengthening the consideration of riparian forests at the basin level and to experiment with new collective governance and construction tools. The aim would be for example to develop integrated restoration programmes and especially to identify the "ecological reference status" to be attained. This point is crucial in order to structure and align the various policies and legislations applying to the riparian forest, which is today the main orphan of our environmental policies.

Let us observe the natural functioning, it is the solution; let us see the riparian forest ecosystem as a partner with whom to converse and as an opportunity for building the future.

Glossary

Soft felling: controlled cutting of a biodiversity issue-tree. The bole and branches of the tree are held up during the cutting and then slowly lowered to the ground in order to prevent any accidental destruction of the fauna sheltering in the tree.

Deciduous: falling annually, like the leaves of many trees.

Windfall: tree uprooted without human action. This can be due to environmental factors (wind, storm, snow, falling of another tree...) or factors that are specific to it (ageing, bad rooting).

Ultrasonic contact: in chiropterology, it is commonly accepted that an ultrasonic contact corresponds to a recording duration of less than or equal to 5 seconds during which at least one bat ultrasound is emitted.

Classified watercourses: designation of the watercourses under the direct support schemes for farmers under the Common Agricultural Policy (CAP), with regard to the objective of good ecological and chemical water status. The tenant or owner of the riverside plot is required to set up and maintain a permanent vegetation cover composed of species that are adapted to the natural surrounding ecosystem on the ground, of a width of at least five metres from the bank. They are designated by prefectural order (Article L211-14) and the list is very difficult to find.

Land clearing: any voluntary operation that has the effect of destroying the wooded state of a land and ending its forest purpose (Article L341-1).

Passive ultrasonic detectors: device with an automatic trigger which records the ultrasounds produced by bats.

Emergence: development phase of insects which makes them pass from the larval stage to the adult stage by multiple physiological and morphological modifications. This can represent high concentrations of insects.

Classified Wooded Areas (EBC - Espaces Boisés Classés): woodland or green space, often in an urban or peri-urban environment, whose land-use or land cover changes are prohibited, in order to preserve the conservation, protection or creation of woodland. Land clearing is thus prohibited, but not cutting.

Spacing factor: ratio between the average spacing between the neighbouring stems (or density of trunks) and the dominant height (which is the average height of the largest trees in the plot). The lower this factor is, the higher the tree density in the plot.

Limiting factor: resource or element that limits the development of an organism, a population or an action.

GEMAPI (Gestion des milieux aquatiques et prévention des inondations - Management of aquatic environments and flood prevention): exclusive and mandatory jurisdiction relating to the management of aquatic environments and flood prevention. It was transferred from the State to the public inter-municipality cooperation establishments (EPCI - Etablissements Publics de Coopération Intercommunale) on 27 January 2014.

Habitat: environment where a population of individuals of a given species or of a group of species can normally live and thrive. It is defined by its ecological characteristics (climate, exposure, geology, pedology) and the human activities taking place there.

Hydromorphological: which concerns the natural physical characteristics of watercourses and rivers and in particular the evolution of longitudinal and transversal profiles and of the planimetric layout.

Hygrophilous: organism needing humidity for its good development. In ecology, an environment is called hygrophilous when it remains damp throughout the year.

Lethargy: marked decrease in the activity of an organism until a slowed mode of functioning is maintained.

Lucifugous: which spontaneously avoids light.

Land control: possession of real rights of occupancy and/or management of a land, which it is not always necessary or possible to acquire.

Earthen bund: raised earth intended to serve as protection against floods.

Micro-habitat: subset of a habitat which corresponds to the small-scale physical needs of a particular (forest, rock, aquatic...) species, in a more or less optimal way, and which changes over time (for instance, the stump of an uprooted tree). In the case of Chiropterans, it is a woodpecker hole, a loose bark, a Cerambyx hole, a crack, or ivy.

Naturalist: natural science and nature specialist

Ecological niche: all the factors of an ecosystem that are necessary for the development of a species.

Real Environmental Obligation: land scheme for environmental protection, based on volunteering, which enables any owner of real property to implement environmental protection measures on their land. It is therefore related to the property, for a maximum period of 99 years.

Phenology: study of certain phenomena of the living world over the seasonal variations.

Phytosociological: which links plant communities and the ecological characteristics of the environment, based on floristic lists.

Vigie-Chiro Protocol: scientific monitoring set up by the French Natural History Museum. It aims to carry out a bioacoustic monitoring of bats to assess their health status. This protocol is open to all and is part of a long-term approach (<http://www.vigienature.fr/fr/chauves-souris>).

Glossary

ACTICHIRO Reference Tool: relative activity of the different species and groups of species in the Mediterranean area. It serves as a reference framework to assess the activity levels recorded (from "low" to "very high"). Some species were grouped according to the similarity of their ultrasonic calls (which can make their discrimination difficult):

GROUPING	SPECIES IDENTIFIED	GROUPING	SPECIES IDENTIFIED
<u>Horseshoe bats</u> <u>(Rhinolophus sp.)</u>	Mediterranean horseshoe bat Lesser horseshoe bat Greater horseshoe bat	<u>Pipistrelles</u> <u>(Pipistrellus sp.)</u>	Savi's pipistrelle Soprano pipistrelle Common pipistrelle Kuhl's pipistrelle Nathusus's pipistrelle Pipistrelles (Pipistrellus sp.) Pipistrelle / Bent-wing bat
<u>Large Myotis sp.</u>	Greater mouse-eared bat Lesser mouse-eared bat Greater or Lesser mouse-eared bat	<u>Kuhl's pipistrelle</u> <u>Nathusus's pipistrelle</u>	Kuhl's pipistrelle Nathusus's pipistrelle
<u>Small Myotis sp.</u>	Daubenton's bat Long-fingered bat Whiskered bat Alcathoe bat Brandt's bat Geoffroy's bat Bechstein's bat Natterer's bat Small Myotis sp.		Schreiber's bat
		<u>Long-eared bats</u>	Grey long-eared bat Brown long-eared bat Alpine long-eared bat Long-eared bats sp. Western barbastelle
<u>Serotine-Leisler's noctule group</u>	Serotine bat Parti-coloured bat Northern bat Leisler's noctule Noctule bat	<u>Low frequency</u>	Greater noctule bat European free-tailed bat

Infilling: filling of a depression area with materials (earth, rubble) up to the surrounding ground level.

Resilience: faculty of an ecosystem, a habitat, a stand, or a population to recover its initial balance and its functionality, after having suffered from major disturbance which can have multiple origins (natural or human).

Riparia: concept presented by Robert J. Naiman, Henri Décamps and Michael Mc Clain as a socio-ecological* system influenced by a number spatial and temporal, but also ecological and anthropogenic dynamics, which calls for an interdisciplinary and integrated approach.

[Robert J. Naiman, Henri Décamps and Michael Mc Clain, Riparia. Ecology, Conservation, and Management of Streamside Communities, 2005].

Saproxylophagous: feeding on dead wood

Anti-return system: system allowing bats to leave their roosts but which then blocks their return (piece of fabric, plastic sheet...).

Socio-ecological system: system which integrates society and nature by considering Man as an integral part of all actors of ecosystems.

Green belt: network made up of terrestrial ecological continuities which include two types of identify: biodiversity reservoirs (areas with a rich biodiversity) and ecological corridors (connections between biodiversity reservoirs owing to favourable conditions for the movement of species).

Xylophagous: living organism whose diet is composed of branches, trunks or roots of dead or living trees.

Wetland: " wetlands are understood to mean the lands, either exploited or not, usually flooded or gorged with fresh, salty or brackish water permanently or temporarily; vegetation, if any, is dominated by hygrophilous* plants for at least part of the year " L211-1 of the French Environmental Code.

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Riparian forests are diverse environments, constantly evolving with the floods and developments. With small surface areas in the Southern region, these biodiversity-rich habitats are greatly threatened. Considering that and the lack of knowledge of their role for bats, the RipiMed study [Ripisylves méditerranéennes - Mediterranean riparian forests] assessed the importance of these woods and their functional roles for Chiropterans, which are true bioindicators of environmental quality. The results show the essential role of riparian forests throughout the life cycle of bats and the crucial importance of the maturity of these woodlands for roosts, food resources and corridors. The study also estimated the functional width of the riparian forest to be between 30-50 m, which is far from what is observed today. Although they are very localised, they seem to play a key ecological role for wildlife at the regional level. The riparian forest is a protected species' habitat within the meaning of the Ministerial Decree of 2007.

Ten discussion workshops have highlighted the fact that management needs to be adapted to preserve and often to restore a functional riparian forest for bats. The legislations, none of which concerns the riparian forest, and evolving practices, are also covered by factsheets - the result of the dialogue between the different stakeholders involved in the conservation and restoration of riparian forests. In order to collectively change the way we take them into account in our control over the territory, an improved governance and new tools are needed.

This book, a restitution of the study carried out in 2018, does not claim to propose solutions to all the difficulties encountered by managers. It provides an overview of the current state and the baseline data supporting new issues that should be taken into account today.



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