Internship Report

Parc Naturel Régional des Pyrénées Ariégeoises

Collaboration in the Project Life Artisan

13. February – 13. April 2024

Foto 1: Landscape within the PNR des Pyrénées ariégeoises, viewed from the vicinity of Bagert. Foto: Sophie Poppe, 2024.

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Professionel internship as part of the bachelor's programme in Geoecology

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Montels, April 2024

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1. Introduction

This internship report is the result of a two-month collaboration in the Life Artisan project of the Parc Naturel Régional des Pyrénées Ariégeoises (hereinafter referred to as PNR), as part of a professional internship for the Bachelor of Geoecology in Bayreuth. The PNR, located in the south of France at the border to Spain and Andorra, is one of 58 regional parks in France and its overseas territories, designated by decree by the state. By designating an area as a PNR, the state recognises its special features, which can be its landscape, such as the Auvergne volcanoes, its flora, e.g. orchids, or its fauna, e.g. lynx, flamingos and mouflons. In the PNR des Pyrénées Ariégeoises, the special features concern both the large number of different natural as well as cultural heritage sites. Here in the Pyrenees and their foothills, natural farming practices such as summer grazing in the mountains, beekeeping and small-scale farming are highly valued and the human influence a part of the region's history and its landscape. On the other hand, remote and inaccessible corners of the park have led to the preservation of relatively untouched ecosystems which give home to some rare animals and plants like the Pyrenean desman (*Galemys pyrenaicus*) and the Bearded vulture (*Gypaetus barbatus*). Since the joint effort of politics and environmental organisations, not least the PNR, the territory is also gradually becoming a habitat for bears *(Ursus acrtos)* and ibex (*Capra pyrenaica*) again (PNR, 2024). The forest of the Pyrenees in Ariège was intensely used up until the 20th century. Today, after about a hundred years of gradual reforestation, natural as well as anthropogenic, the forest covers about 125 700 ha, corresponding to more than 55 % of the PNR's area. 83 % are deciduous trees, primarily oak (*Quercus*) and beech (*Fagus sylvatica*). Various preceding studies on the vulnerability of these forests in the face of climate change ascertain already visible effects like a foliar deficiency and an elevated mortality of conifers (Barrault et al., 2022). As the pressure on the vegetation is expected to augment in the future, together with PNR the project Life Artisan searches nature-based answers to these changes, options for their mitigation or avoidance (OFB 2022). To trace further developments, a first inventory of the forest is executed by using the remote sensing method LiDAR. The next stage and the focus of the interns work at the PNR is the calibration of the LiDAR in cooperation with the ONF and the ANA-CEN Ariège.

2. Presentation of the Employer : Le Parc Naturel Régional des Pyrénées Ariégeoises

In 2009, part of Ariège, consisting of 138 municipalities, 2 465 km^2 and 44 467 inhabitants (2017), was given the status of a PNR. Since then, a team which meanwhile reaches about thirty people, has taken care of nature conservation, wildlife reintroduction, agriculture, education, preservation of historic buildings, forests, landscape management, tourism and energy production and use in the PNR (PNR, 2024). The organisational centre of the PNR is located in the Ferme d'Icart in Montels, in the north-western part of the park's territory. A reunion of all employees of the PNR is held once a month, giving the room for presenting newcomers and changes and offering an insight into the fields of work of colleagues.

At the park, I am employed as an intern by Raphaële Hemeryck and Elodie Roulier. Elodie Roulier is the head of the Space and Landscape Department ("Pôle Espaces et Paysages") and deals with the organisation of many topics and several employees in the conflicting priorities between forest use and conservation. Raphaële Hemeryck works for the protection of the forests in the regional park. In this context, she is also responsible for organising the park's participation in the Life intégré Artisan project, for which I am working during my time at the PNR.

1.1 Life intégré Artisan

The Life intégré Artisan project (for short Life Artisan) is led by the Office Français de la Biodiversité (a public organisation for the protection of biodiversity) since 2020 and is 60 % funded by the EU. Together with 27 partner organisations, the project seeks nature-based solutions to the problems of climate change, so-called SafN (Solutions d'adaptation fondées sur la Nature). As an example, the project cites the replanting of mangrove forests in French oversea territories as natural protection against flooding and cyclones. The declared objectives of the project are to demonstrate and evaluate the potential of SafN, to raise awareness and train stakeholders in this field of work and to monitor and expand SafN projects in France and the overseas territories (OFB*,* 2022*;* OFB, 2024).

1.2 PNR's Contribution to the Life Artisan Project

The PNR des Pyrénées Ariégeoises is a test site for adapting the Pyrenean Forest to climate change within the framework of the Life Artisan project. Since then, 2020, various projects have already taken place. To begin with, the PNR organized a conference on the impact of climate change on forests as well as the existing (nature based) solutions. In a next step, the PNR has provided the necessary support for the establishment of a regional branch of Sylv'ACCTES on the territory of the park. Sylv'ACCTES is an association for sylvicultural projects to help forest owners financially and advisory with the implementation of a forest management that is in line with the idea of sustainability of Sylv'ACCTES. In concrete terms, that means an irregular forestry, based on the natural regeneration of mixed local species and choosing a way of exploitation that limits the impact on the soil as far as possible. Another project of the PNR within Life Artisan was a study on the vulnerability of the forests on the PNR's territory, supported by the scientific organisms AgroParisTech (Nancy) et Dynafor (Toulouse). Moreover, the PNR organized various thematic workshops for forest owners and other interested participants. Currently, one part of this project, is following the forests' evolutions through building an observatory, taking stock and collecting data using the LiDAR HD. The continuation of the project envisages to experiment on 15 study sites, on which various SafNs are to be trialled and compared with "classic" working areas. With help of the LiDAR HD, another goal is to set up permanent survey points in the forest, to monitor the effects of climate change. LiDAR HD coverage throughout France was already provided for in the "Plan de Relance" (a financial plan of the French State to help restarting the economy after COVID) for the period between 2021 and 2026. In the Occtinanie region, a plane charged with the LiDAR cartography passed in 2021 and 2022. The LiDAR imaging enables 3D mapping, which can be very useful for many issues if used correctly. In cooperation with the ONF (Office National des Forêts) and the ANA-CEN Ariège (Association des Naturalistes d'Ariège – Conservatoire d'Espaces Naturels départemental), the PNR decided to use LiDAR mapping for the Life Artisan project. In order to use the cartography issued by the plane, the LiDAR must be calibrated. For this purpose, data must be collected in the field within a maximum of two years after the plane has flown over, to minimize the changes in the vegetation cover since the LiDAR. This field work, collecting the necessary data for the calibration, is executed by three binoms, usually consisting of a professional forest manager and an intern, employed to two thirds by the PNR and to one third by the ANA-CEN and the ONF. A technical support is issued by the ONF. The aim of the PNR's involvement in the Life Artisan project is to survey the characteristics of the forest on the territory (tree species, height, diameter, standing capital), biological production, identification of very large trees for their contribution to biodiversity and increasing the proportion of the forest subject to a utilisation plan or forest management.

1.3 Mode of Operation of LiDAR HD

LiDAR, Light Detection and Ranging, is an active remote sensing method for creating a detailed cartography in three dimensions. It therefore replaces a time-consuming and sometimes dangerous on-the-ground method. Especially in the mountain forests of Ariège, some terrains are simply not accessible from the ground and the vast dimensions of the forest doesn't allow an exhaustive examination. The LiDAR method allows an automatized, fast and area-wide recording which requires a comparatively low labour input. Active means, that the method is producing energy, in this case rapidly firing laser beams that are sent from an airplane to the ground (Wasser, 2024). When the light hits an object, it can be absorbed or re-emitted into different directions. Parts of it travel further to the ground to be reflected there, parts of it being spread by branches and leaves towards the plane and received by a sensor that is implemented in the LiDAR system. The amount of returning light, its intensity, creates a waveform with its peaks according to the areas where more light is being reflected (Figure 1). These peaks arise at different heights, perceived by the receiver as time-delayed returns of the light to the plane. The time it takes the light to travel to the ground and back is called a two-way travel time and provides the information of the distance of the object (z-value). By also determining the position of the laser via GNSS (Global Navigation Satellite System), this method gives each point an x, y and a z-value (Wasser, 2024). All these data results in a so-called LiDAR point cloud (Figure 2). The next step, mostly automatized, consists in a classification of the points, in which outliers are eliminated and all other points are labelled. Afterwards, further information can then be displayed using various models, for example the height of the tree tops above the ground using the "Modèle Numérique de Hauteur" (MNH), a digital height model (ONF, 2018; IGN 2023). In order to apply the data given by the LiDAR, the cartography issued by this method must be calibrated. For this georeferencing, some field work is still necessary but is restricted to small study sites with a radius of fifteen meters and leaving out dangerous or inaccessible areas. To ensure that the samples are representative, a grid was created over the PNR's territory, containing about 750 survey points in the forest to be systematically visited and measured. To avoid great changes in the vegetation cover that complicate the calibration, the on-the-ground measurements must be finished within two years after the LiDAR cartography. The measurements at all survey points must therefore be completed in 2024.

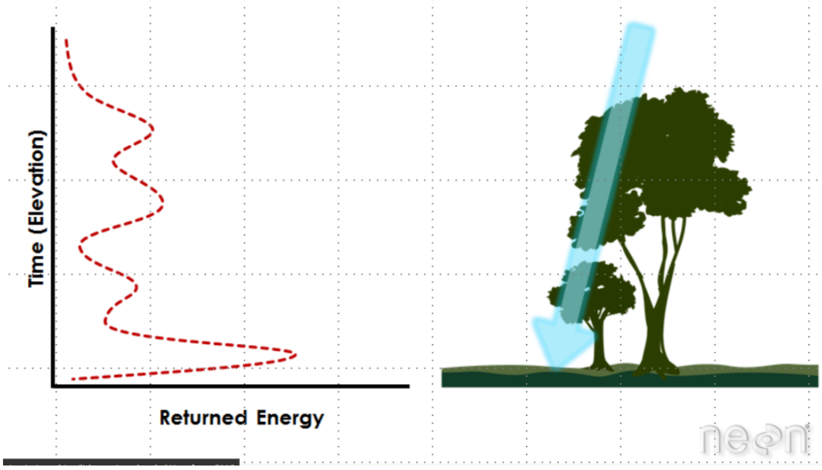

Figure 1: Waveform created by the light returning time-delayed from two trees and the ground, peaks resulting from the intensity of the returning light. Source: Wasser, 2024.

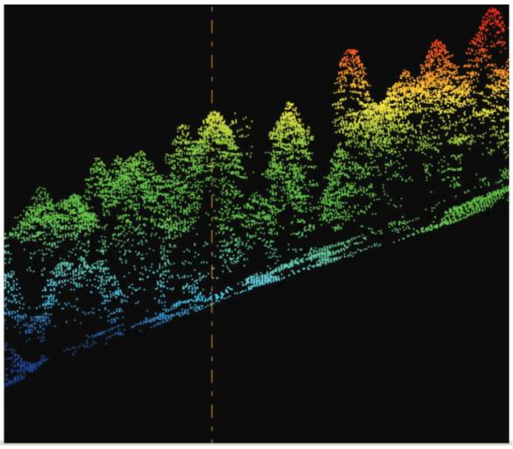

Figure 2: LiDAR point cloud, distances to the sensor marked in colour. Source: Formation Chef de Projet LiDAR aéroporté v 1.0 juin 2018.

3. Tasks of the Intern: Field Work to Calibrate the LiDAR

The intern's main tasks consist in the organisation and carrying out of the field work to collect the necessary data for Life Artisan. This includes:

- checking and ensuring the function of all necessary tools in the field
- planning the points to be surveyed and their access routes
- organisation with the respective forestry workers to carry out the survey together
- cooperation in the carrying out of measurements in the field
- communication with residents or owners of the forest areas to be surveyed
- data backup of the field work and upload to the shared drive folder
- visualisation and documentation of the progress of the work via Excel and QGIS

2.1 Preperation

The fieldwork in the forest of the Pyrénées ariégeoises serves to calibrate the LiDAR. The permanent survey points were laid out as a grid over the entire area and the points that fall on towns or fields were deleted. All remaining about 750 points must now be approached individually. An excessive slope (>80°), field, water or a road at the location of the coordinate can still lead to the deletion of the point, but the percentage is quite low due to the preliminary work. The entire survey area was divided into 53 quadrants, labelled from A4 to H7 (Figure 3). For each of these quadrants there is a map showing the altitude, the survey points to be visited (hereinafter referred to as plots), locations, rivers and the passability of the roads at a scale from "good" to "impassable" (Figure 4). Part of the trainee's preparation is the good organisation of the maps to avoid double visiting a plot and to determine the best route and meeting point for the survey of several plots in one day. The ONF has drawn up a step-by-step protocol ("Protocole pour la mise en place et la mesure des placettes de l'observatoire des Pyrénées ariégeoises") to ensure that the plots are surveyed in the same way. To distribute the workload, the survey points are divided into private and public forests. While the ONF and the ANA are responsible for surveying the points in the public forests, the PNR is in charge of the private forests.

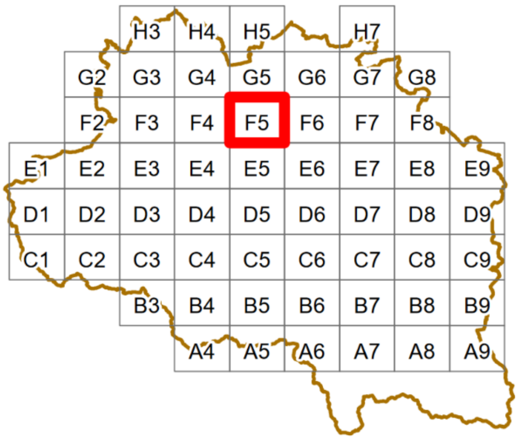

Figure 3: Division of the PNR area that is to be analyzed into quadrants. Marked in red the map, usually printed next to it (Figure 4). J. Duclaux, PSIM Toulouse, 2023.

Not less important for a smooth realisation of the field work, is the communication with owners and neighbours of the forests surveyed. A communication about the implementation of the permanent study points was done in 2023, yet there are many encounters with neighbours, who did not get the information. To help the understanding, a flyer was created to explain the mission and resolve the concerns of some inhabitants (appendix 1). The most questions, however, are posed by residents with merely benevolent interest and the conversations arising often help the survey team to find the best way to the study plot.

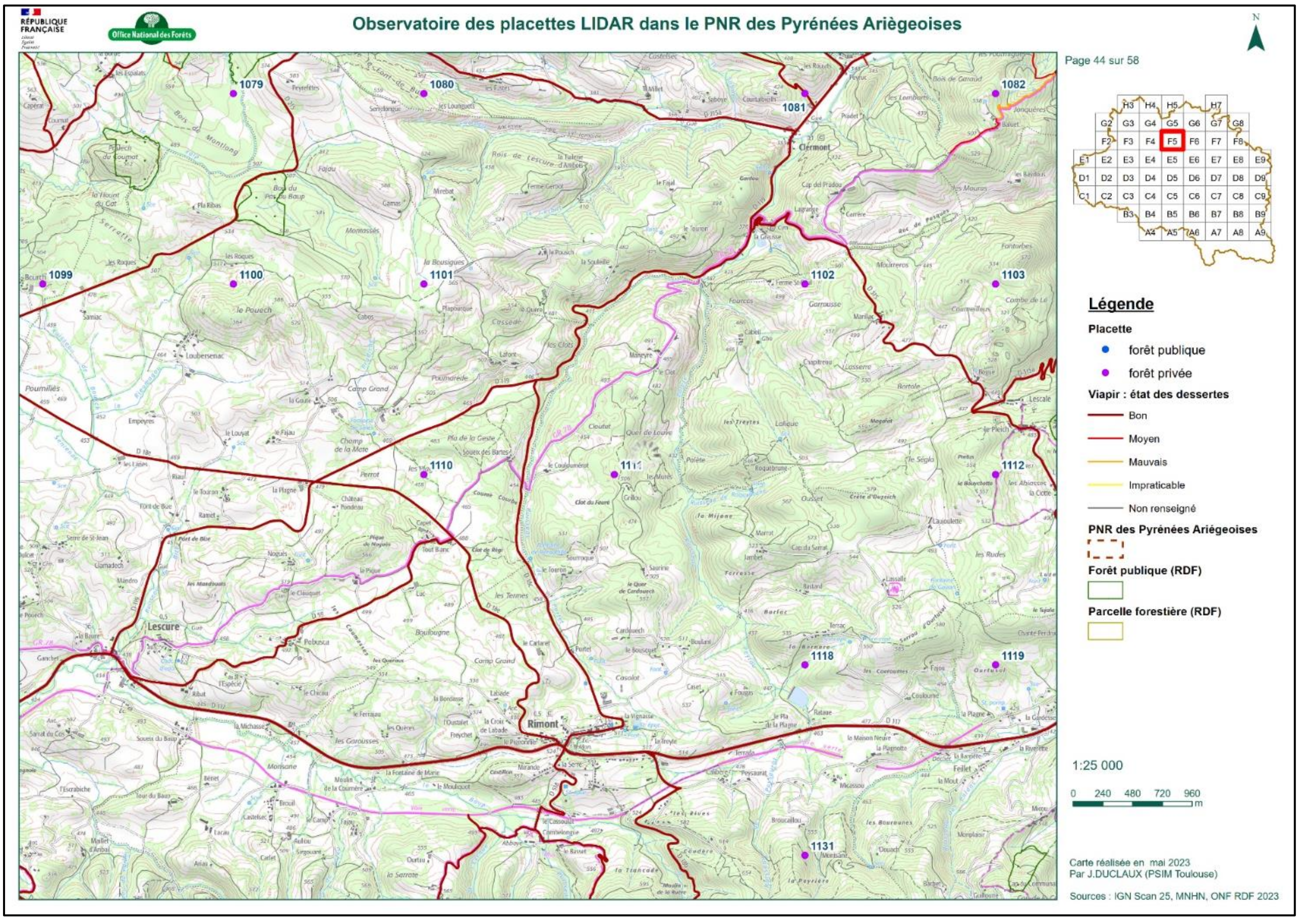

Figure 4: Map F5 as an example of the maps used to locate the survey points. Blue dots are study sites in private forest areas, purple dots in private forest areas. The roads and forest tracks are marked from red (good) to yellow (impassable). J. Duclaux, PSIM Toulouse, 2023.

2.2 Execution of the Field Work

The survey points are always approached by at least two people together, firstly for the safety of those involved, as the plots are always located in the forest with sometimes dangerous access, and secondly to ensure efficient work on site. A survey team is called a binom and at the PNR always consists of an independent professional forest manager and another person, usually an intern. At the end of the passable roads, the binom continues on foot. The exact location is searched via GPS using the app *GéoRelevé*, and the centre of the survey point can be determined once it is less than five meters away. This should be at least two meters apart from any surrounding trees so as not to obstruct the exact determination of the location by Trimble GPS. A metal rod is put into the ground at the centre to enable the exact point to be found again later. The following data is now collected within a radius of 15 metres:

1. Registration of the exact Location

With the help of the GNSS Trimble (Global Navigation Satellite System), a highly precise GPS, the exact location can be determined and transmitted. The app *SPace* allows to monitor the precision by displaying the exact number and localisation of the available satellites over the survey point on the *Skyplot* map. If the satellites are too far away or too few in range, this can lead to inaccuracies. At an exposed location, there are often 20-30 satellites in the vicinity, of which at least eight, preferably fifteen, are used to determine the exact position according to the protocol. The SBAS (Satelllite basse altitude géostationaire), which are shown in red, are particularly suitable for determining the location.

If enough satellites are available, a new project is created in ArpentGIS, available as an app on the Trimble, for each day in the terrain. A new object, the GPS point, is then created within the new project and the precise localisation is started directly from the app. The Trimble receiver should be positioned horizontally on the tripod above the metal rod and the binomial should step away from it to facilitate a localisation with as little interference as possible (Foto 2 and 3).

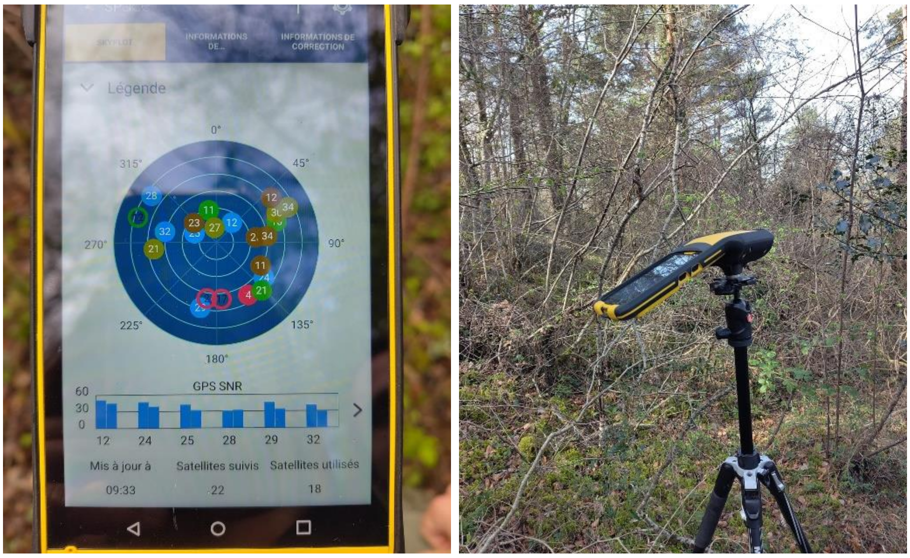

Foto 2 and 3: GNSS Trimble, left: View of the app SPace for checking the available satellites, right: Trimble setup over the centre of the survey point. Foto: Sophie Poppe, 2024.

2. Measurement of the Study Site

Once the localisation is complete, the plot can be measured. For this part, the app *Inventaire* (Foto 4) is used, facilitating the data to be recorded with the smartphone for each plot. Once the data has been synchronised with the ONF server, it also shows the point as "completed", thus avoiding double surveying a location. Before the survey can start, the app asks for the name of the forest, the plot, the head of the binom (the professional forestry manager responsible) and "Placette limite". The latter is used when a plot falls on a spot that cannot be surveyed for lack of forest, but data can still be collected by moving the point slightly. In this case, the centre of the plot is shifted. It's important to note the distance of the new centre from the old one in meters and degrees, in order to find it again.

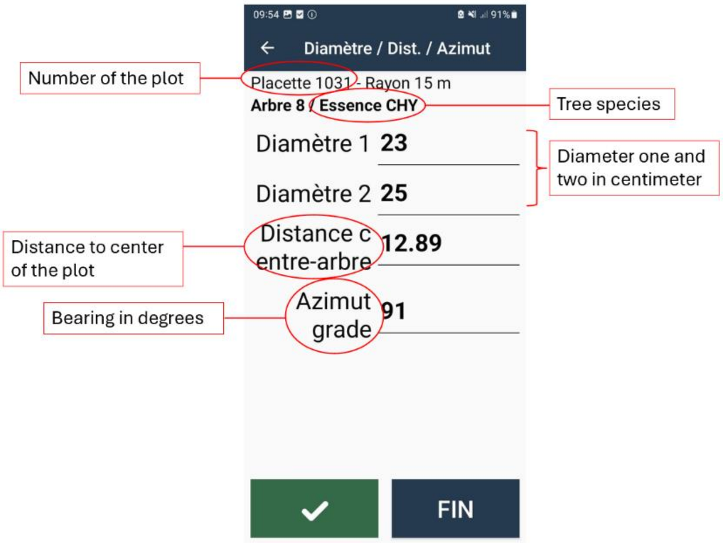

Foto 4: View of the app Inventaire, recording of tree measures. Screenshot: Sophie Poppe, 2024.

Foto 5: Deployment of tree caliper in the field. Foto: Marie Sallebert, 2024.

At the plot, a radius of 15 metres is examined. In the next step, the app asks for the type of tree. This can be difficult to determine, especially in winter or with hybrids. In some cases, known to be hard to specify, there are options such as "native oak species" or "pine other than *Pinus sylvestris* or *Pinus pinaster*". Normally, however, the tree species can be determined based on its growth habit, bark, buds or old leaves and fruits on the ground or at the branches. In questionable cases using the identification guide Flore Forestière Française. During the first weeks of internship an herbarium was prepared, helping the intern to distinguish the most common trees in Ariège. After entering the species, a page opens on which two diameters, the distance to the centre and the position in degrees must be entered (Figure 4).

According to the protocol, the diameter of a tree is always measured at 1.30 m with a tree caliper (Foto 5), the first parallel to the centre (tips of the tree caliper towards the centre or exactly away from it), the second at a 90° angle to the first diameter. If one stands on a sloping surface, the measurement is always taken from the higher point. According to the protocol, only trees with a first diameter >17.5 cm are included in the inventory.

The distance from the tree to the centre of the plot is determined using a Vertex hypsometer (Foto 6 and 7). This device works via ultrasound to determine the tree height, distances, inclinations and angles. In this survey, the exact distance from the centre of the tree at a height of 1,30 m to the centre of the plot is determined. Therefore, the orange receiver (Foto 6) is placed at the center of the plot, at a height of 1,30 m as well, while the vertex is placed and the center of the tree to be measured (Foto 7). In this way, the Vertex takes the inclination into account by using the modus "angle". As it works with ultrasounds, the function of the Vertex can be disturbed by noises, such as a close by river.

Foto 6 and 7: Deployment of the Hypsometer Vertex in the field, left receiver, right Vertex. Fotos: Sophie Poppe, 2024.

Foto 8: Compass to determine the bearing in degrees. Foto: Sophie Poppe, 2024.

Finally, a compass is used to determine the bearing in degrees from the centre of the plot (Foto 8). If these measurements are validated in the app, the tree needs to be classified as "alive" or "dead", then follow the data of the next tree. Once all standing trees have been measured, the next step is to record the deadwood. Only trunks with a diameter of at least 30 cm over a length of 50 cm are taken into account, as well as their state of decomposition on a scale from 0 (unchanged) to 4 (rotten over more than 3/4 of the diameter).

3. Dendromicrohabitats

Once the measurements have been completed, the binom notes the trees that are considered a tree-habitat, using another app called *GéoRelevé*, as well as the illustration of dendromicrohabitats according to Larrieu, Paillet, Winter et al. 2018 (Figure 5). A tree-habitat is a tree, that carries at least one dendromicrohabitat, i.e. a morphological feature, that might harbour different species such as plants, fungi and animals (Foto 9, 10 and 11). This feature might be for example a woodpecker's hole, which are not only a sign of woodpeckers in the forest, playing the role of a natural pest control, but also a home to bats, coleoptera and butterflies, among others (Bütler et al., 2020a). For better comparability and in order not to go beyond the scope of feasibility, at the plots for the LiDAR calibration each tree with a first diameter > 42.5 cm is considered a tree-habitat. In *GéoRelevé* one notes its number in the inventory, the first diameter, the tree species and then classifies the form of microhabitats that are present on the tree. This data is not relevant for the calibration of the LiDAR, but it is important for the localisation of forests that are particularly worthy of protection and is therefore a concern of the PNR and the ANA-CEN Ariège.

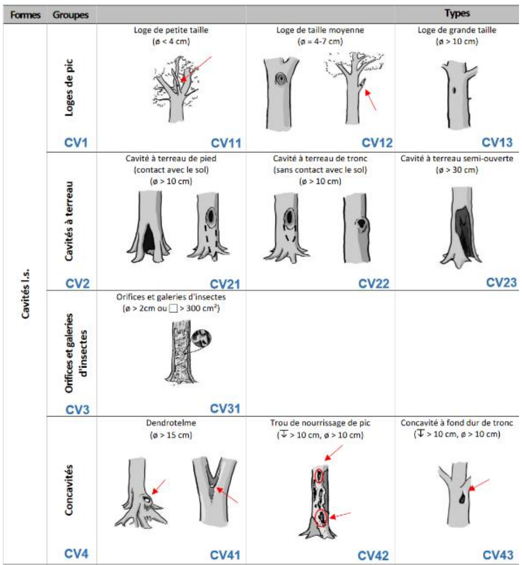

Figure 5: Excerpt from the identification guide for dendromicrohabitats according to Larrieu, Paillet, Winter et al., 2018. Full document in the appendix.

Foto 9, 10, 11: Left: Woodpecker feeding holes, center: peeling bark forming a shelter, right: dendrotelm. Fotos: Sophie Poppe, 2024.

4. Documentation

At the end of the measurements on a plot, four photos are taken, one for each cardinal point, as well as of remarkable trees on the site. These are used for illustration, communication with partner organisations and residents, but also as a thought support in the follow-up.

2.3 Follow-up

The follow-up includes, above all, data backup and documentation of the journey and the completed plots, for the purpose of saving, stacking and sharing the data, following and representing the progress as well as the cost reimbursement of the journey. The data backup includes:

- Sending the measurement data of the trees to the ONF network, which is done directly from the app *Inventaire*
- loading the GPS data as bak- and agi-file onto the computer and converting it into shape file via ArpentGIS
- saving the data from the app *GéoRelevé* on the PNR server
- Stacking the photos
- uploading all the above-mentioned data to a shared drive folder

Here too, it is important to follow the protocol exactly, especially regarding the naming of the files, so that they can be easily found again. Subsequently, the journey is documented in several Excel tables, to record the completed survey points, their accessibility, comments and equally for the success of the respective data backup.

To illustrate the progress of the work, there is a map on QGIS in which all plots are shown, each with their status "measurements completed" or "deleted" (Figure 6).

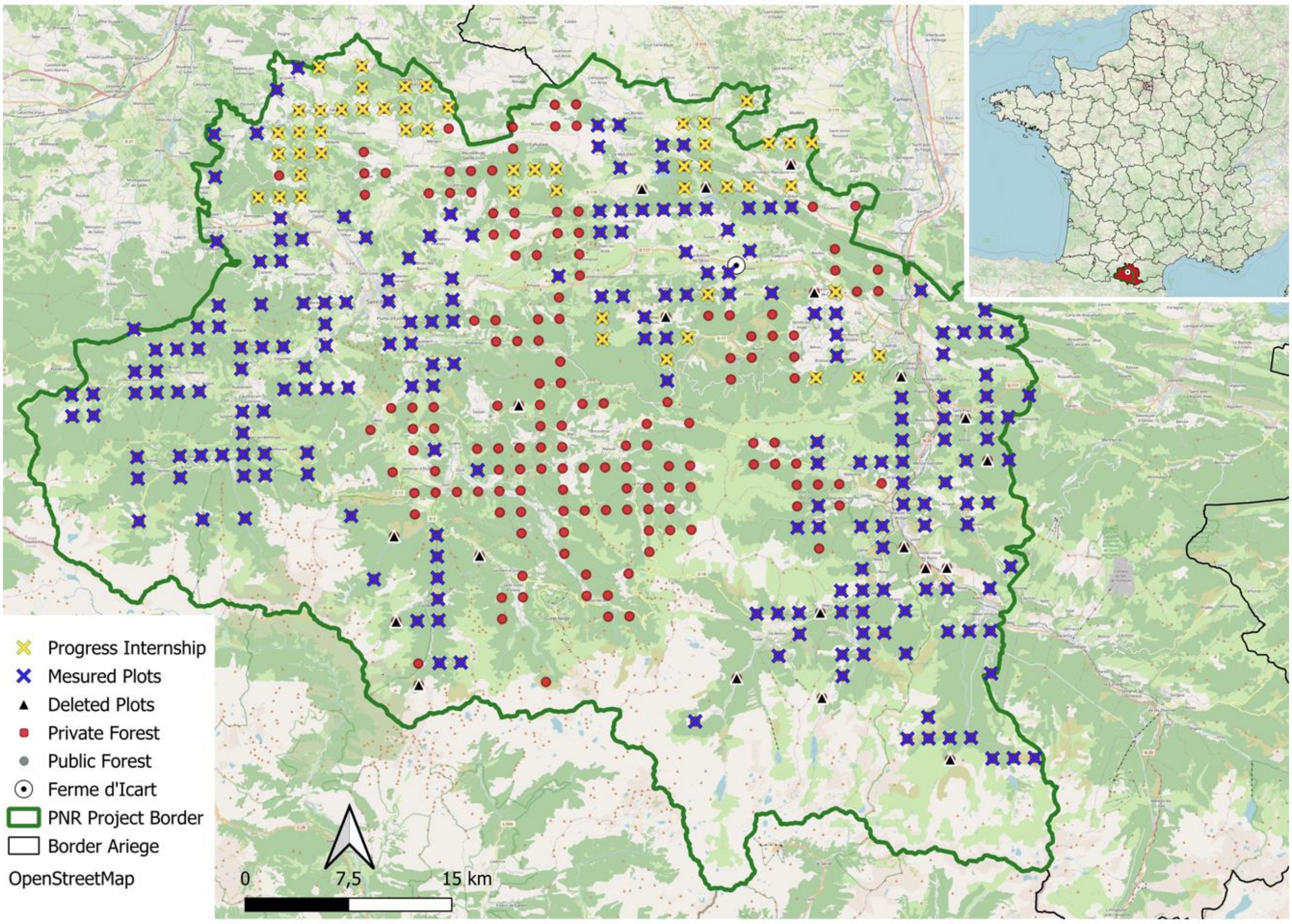

Figure 6: Representation of the actual state of the project via QGIS (status on 12.04.2024). In yellow: plots visited during the time of this internship. Basis: OpenStreetMap, map done and updated by various interns of the PNR, own illustration.

2.4 Reunion and Recalibration Between the Teams

Cooperation and distributing the workload is essential within a project at the scale of the Calibration of the LiDAR yet it entails the risk of different individuals working in different ways. In order to ensure the comparability of the data, the 02.04.2024, a whole day was invested for recalibrating between the teams of the ANA-CEN Ariège, ONF and the PNR. After a conference about the current state of the project, questions and changes in the protocol, the used applications and the follow-up were discussed. Subsequently two plots were visited in the vicinity of the Ferme d'Icart (the PNR's office), whereof the first one had to be deleted, the second one was measured together. This way there was the space to recapitulate each step, detect different approaches and comparing the individual evaluations, concerning for example the classification of microhabitats.

4. Discussion of the Results

During the time of this internship, the team made steady progress in the mission. While in February 2024 the meteorological conditions led to some cancellations of field workdays, March and April were put to good use. All in all, 54 plots were surveyed, mostly in the northern, lower (in terms of altitude) territory of the PNR, to avoid problems with snow covered plots and accesses. At 32 out of 54 plots tree-habitats where recorded, representing 59,3 % of the survey points. Three plots had to be deleted for lack of forest at the site. The aim of this mission, a first inventory for the implementation of permanent study points all over the area of the PNR, is not in itself giving a result. Yet, once the survey is completed, it will be very interesting to see the distribution of different kinds of forests at the PNR and further on facilitate the monitoring of their development. The data collected might also allow the localisation of forests with a high percentage of tree-habitats and under certain circumstances allow the implementation of corridors between some of them. This could ensure the safe movement and exchange of animals and plants (Ministère de la Transition écologique et de la Cohésion des territoires, 2023). A team at the PNR, charged with the project TVB (" trame verte et bleue"), work on the implementation of these corridors (PNR, 2024). Regarding the tree-habitats, the diameter of 42.5 cm, used as a definition for tree-habitats in the field, felt like a great simplification for the statistics. In fact, it is not only the diameter providing information about the presence of dendromicrohabitats and thus their significance for biodiversity. The age and the species also play an important role in the development of these morphological features (Bütler et al., 2020b). Many environmental factors, on the study site especially in connection with the different altitudes, have a great influence on the diameter of the tree. Therefore, some species even when very old, never reach the diameter necessary to appear in the inventory done in connection with the calibration of the LiDAR but still carry a great number of dendromicrohabitats. In order to finish the inventory for the LiDAR in time, this simplification was definitively necessary, and the data collected give a first idea about the location of dendromicrohabitats. Yet, once the permanent study points are implemented, additional studies on this topic might be very valuable and the limitation on the diameter along with its shortcomings should be considered before implementing measures on basis of these data. The internship of another student at the ANA focuses on this topic. Likewise simplified due to time constraints was the notation of deadwood, requiring a diameter that was often not reached, even when deadwood was found on the site. Another intern at the PNR will concentrate his time on the possible uses of the data obtained during the field work. However, the main issue of this internship, the continuation of the inventory to calibrate the LiDAR, is on the right track. If the current work rate can be maintained, the mission in the private forests will be finished well before the end of the second growing season after the LiDAR. This will be necessary to support the binom of the ANA-CEN and the ONF at their field work in the public forests, which are not yet that far advanced. With the help of this joint effort, nothing should stand in the way of completing the project in time.

5. Evaluation of the Internship

My internship at the PNR des Pyrénées ariégeoises was a fully positive working experience. The organisation within the PNR facilitates a very free time management, restricted only by the workload and the cooperation with colleagues. The field work was additionally impacted by the weather, which required a little bit of flexibility, resulting repeatedly in very long field days and shorter days at the office. However, during the internship I had a great freedom in organising my days and was always surrounded by cooperative and helpful colleagues, at the PNR as well as at the ANA and the ONF. I also enjoyed the full access to a lot of interesting literature on the Pyrenees, forests and plants, as well as the chance to improve my GIS-skills. The presence of another intern was especially helpful during the period of arrival and orientation at the new position and tasks but also later on I appreciated the interaction and the shared responsibility for the field work. The collaboration with two independent professional forest managers allowed an insight and exchange of experience with another profession. They had an immense practical knowledge about the flora of Ariège to share, taught me a lot of forestry vocabulary, such as the meaning and estimation of the basal area or the density of the forest, as well as the use of forestry equipment. This internship also familiarised me with some useful applications in the field work, gave me practice in orientating myself on paper maps and required a lot of teamwork. The many hours I spent in the field gave me a great opportunity of discovering the regional park, its unique geology and climate resulting in a wide variation of ecosystems. I learnt to identify the most common tree species on the area of the PNR by their shape, growth habits and buds, as well as some typical associations of trees and indicators for moisture and drought. During the first weeks of my internship, I worked on an herbarium, which helped me to expand my vocabulary, as well as gaining confidence in identifying trees in winter. In the future I hope it to be useful to the next interns. In the field I was also sensitised to the importance of dendromicrohabitats and learned how to recognize them. Additionally, the proximity of nature awakened my interest in insects and the measurements often left time to identify herbs and animals we crossed. Finally, my French language skills improved greatly. Although I still reach my linguistic limits every day, I enjoyed the interaction in a different language, and gained a lot of confidence in it while concentrating on different subjects. During the field work we often attracted the attention of neighbours and passers-bye, making it necessary to explain our mission. Especially after having designed a flyer for the easier communication, I noted that these conversations were less challenging for me and became a pleasable experience in my working days. I believe that two months were a good amount of time to get to know my part of the work for Life Artisan and gaining a lot of knowledge. Yet, I think that more time at the PNR would have given me the opportunity to understand the structure and organisation of the park better and enter more profoundly into the ideas and challenges of the project Life Artisan. There are a lot of different fields of work at the PNR and I feel like I did not take sufficiently advantage of their proximity, in order to get additional insights into different working positions. Furthermore, I think that the same experience in a German regional park might still be beneficial, on the one hand for the comparison of similar structures in two different countries, on the other hand for the lack of the linguistic barrier. To sum it up, I enjoyed my internship in the PNR a lot and feel very grateful for having been given this opportunity. I still have a lot of questions about my future career and look forward to other working experiences, but I can definitively imagine a work in a structure as the PNR. Moreover, I had the chance to improve a large number of different skills which will be useful in any of my future jobs and feel this internship to have been very valuable for my personal development.

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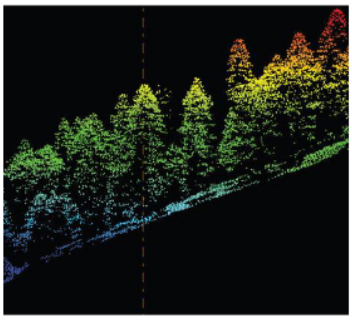
Appendix

1. Flyer for easier communication with residents, own illustration

Parc naturel régional Pyrénées Ariégeoises

Qui sommes-nous ?

Nous travaillons pour le Parc Naturel Régional des Pyrénées Ariégeoises, qui participe au projet Life Artisan. L'objectif est d'apporter des réponses durables au réchauffement climatique. Dans le cas de la forêt ariégeoise on cherche à préserver ou rétablir une forêt résiliente et fonctionnelle. D'une part pour la production de bois et d'autre part pour la biodiversité, tout cela en considérant la pression croissante que le changement climatique exerce sur la forêt. Une étape importante dans ce travail est de cartographier la forêt ariégeoise grâce au LiDAR.



Résultat de la cartographie LiDAR : Nuage de points avec des couleurs selon sa distance à l'avion.

Qu'est-ce que c'est, le LiDAR ?

LiDAR (Light Detection and Ranging) est une méthode de mesure qui utilise des faisceaux laser, c'est-à-dire la lumière, pour mesurer des distances. Le LiDAR fonctionne comme un radar dirigé par un avion. Après le traitement des données, on obtient une cartographie 3D. On peut voir les arbres, leur hauteur, mais aussi le sol, les bâtiments, etc.

Qu'est-ce qu'on fait sur le terrain ?

L'avion est passé sur Ariège entre 2021 et 2022. Nous réalisons maintenant des relevés sur le terrain afin de recalibrer les données cartographiques issues de l'avion et installer ainsi des observatoires permanents. Dans ce but, nous nous rendons sur plus de 800 points dans les forêts en Ariège et faisons des mesures à l'aide de méthodes non-invasives. Par la suite nous comparerons les données avec les données acquises par le LiDAR. Dans un périmètre de 15 m autour du point GPS donné, nous mesurons le diamètre des arbres, leur distance par rapport au centre, leur essence et la présence d'arbres abritant d'autres espèces, appelées dendromicrohabitats. Notre passage n'a aucun impact sur la forêt.

Ça sert à quoi ?

Avec la cartographie 3D faite par le LiDAR et contrôlée par nos mesures sur le terrain, nous recevons une carte assez détaillée et pleine d'informations importantes sur la forêt. Par exemple, on peut localiser des forêts avec une plus grande proportion de vieux arbres ou nous donner une idée sur la distribution d'espèces étrangères. En comparant la cartographie sur plusieurs années, les changements du couvert végétal seront un indicateur de la santé de la forêt. Cela nous aidera à observer les effets du réchauffement climatique afin d'élaborer des réponses adaptées.

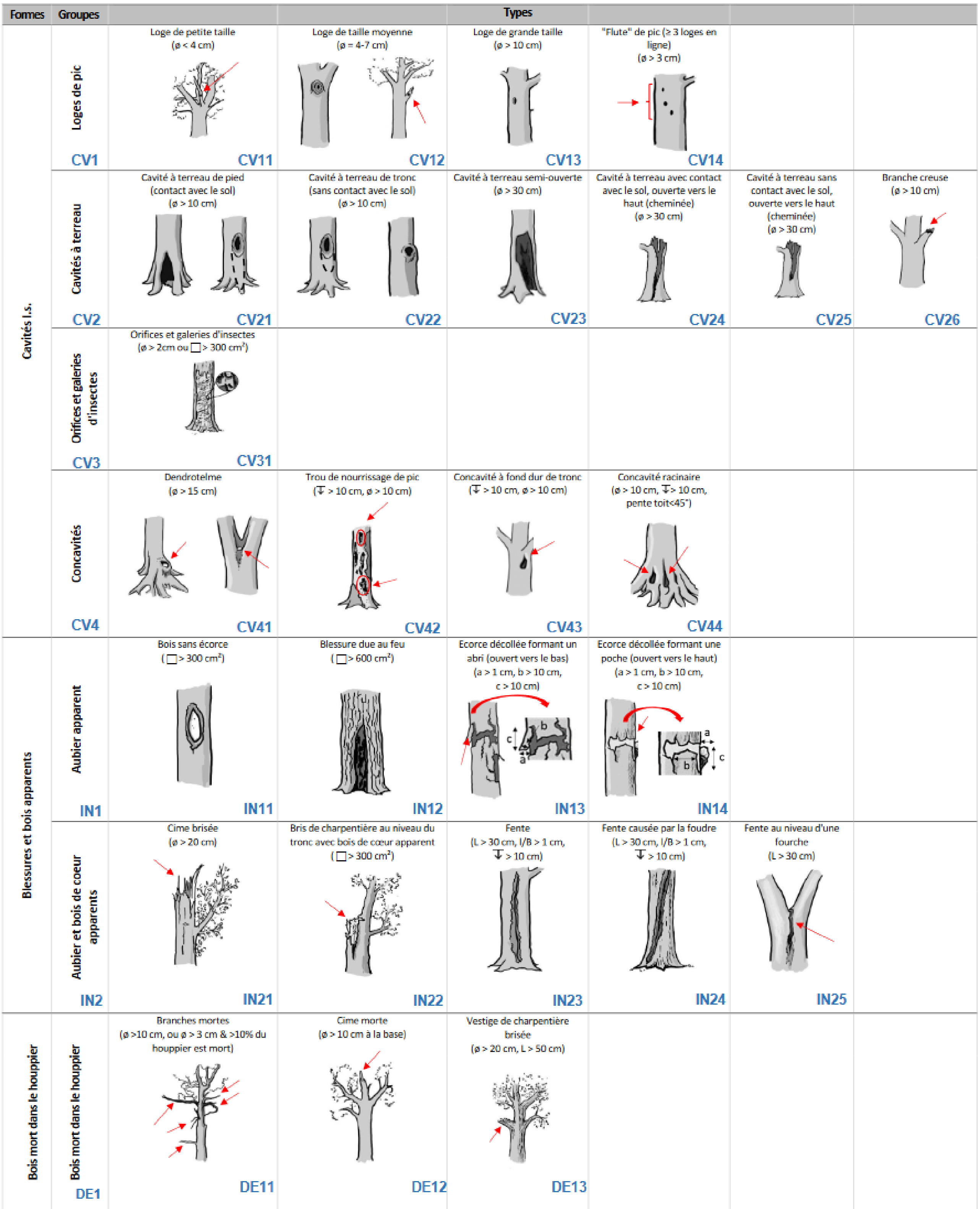
Life artisan

Le climat change, adaptons-nous avec la nature

2. Identification guide for dendromicrohabitats according to Larrieu, Paillet, Winter et al., 2018.

Illustrations des dendromicrohabitats (d'après Larrieu, Paillet, Winter *et al.* 2018)

Ø : Diamètre ; ↧ : Profondeur ; □ : Surface ; L : Longueur ; l : largeur ; CV11 : code du dendromicrohabitat



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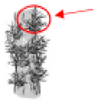
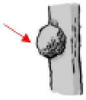
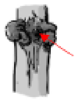
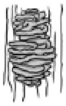
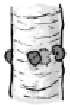
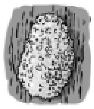
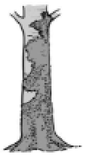
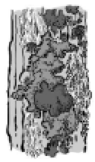
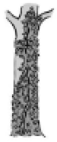
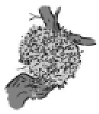
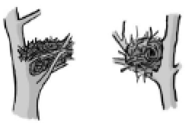
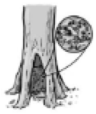
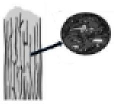
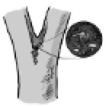
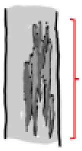
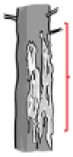
Formes	Groupes	Types					
Excroissances	Agglomérations de gourmands ou de rameaux GR1	Balais de sorcière (ø > 50 cm)  GR11	Gourmands / Brogne (> 5 gourmands)  GR12				
Excroissances	Loupes et chancres GR2	Loupe (ø > 20 cm)  GR21	Chancre (ø > 20 cm ou grande partie du tronc couverte)  GR22				
Sporophores de champignons et Myxomycètes	Sporophores de champignons pérennes FU1	Polypore pérenne (ø > 5 cm ou N > 10)  FU11					
Sporophores de champignons et Myxomycètes	Sporophores de champignons éphémères et Myxomycètes FU2	Polypore annuel (ø > 5 cm ou N > 10)  FU21	Agaricale charnu (ø > 5 cm ou N > 10)  FU22	Pyrénomycètes (ø > 3 cm ou □ > 100 cm^2)  FU23	Myxomycètes (ø > 5 cm)  FU24		
Structures épiphytiques, épixyliques ou parasites	Plantes et lichens épiphytiques ou parasites EP1	Bryophytes (mousse ou hépatique) (□ > 10% du tronc)  EP11	Lichens foliacés ou fruticuleux (□ > 10% du tronc)  EP12	Lierre ou lianes (□ > 10% du tronc)  EP13	Fougères (> 5 frondes)  EP14	Gui (ø> 20 cm)  EP15	
Structures épiphytiques, épixyliques ou parasites	Nids EP2	Nid de vertébré (ø> 10 cm)  EP21	Nid d'invertébré  EP22				
Structures épiphytiques, épixyliques ou parasites	Microsols EP3	Microsol d'écorce  EP31	Microsol du houppier  EP32				
Exsudats	Coulées de sève et de résine EX1	Coulée de sève active (L > 10 cm)  EX11	Coulée abondante de résine (L > 10 cm)  EX12				

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