TRAMETES 2

CONTRIBUTION OF OLD-GROWTH STRUCTURAL ELEMENTS TO THE CONSERVATION STATUS OF FOREST HABITATS AND SPECIES

Métaprogramme BIOSEFAIR

Bilan de projet : 2021 - 2024

March 2025

The assessment of the conservation status of forest habitats is mainly based on indirect methods describing the habitat (structural indices, and composition). Concerning species of conservation concern, the contribution of forest structural elements to their status is still poorly understood, and consequently, the link between the conservation of natural habitats and the conservation of species remains relatively unclear—particularly the respective roles of Tree-Related Microhabitats such as black woodpecker cavities and forest maturity.

TRAMETES 2 complemented a project funded by the French Office for Biodiversity.

Through the study of five forest sites in metropolitan France, we installed 80 paired plots: one with at least one black woodpecker cavity and one without (control). We described the forest structure of these plots, then we equipped them with eco-acoustic sensors for determining bird communities and sampled for fungal communities associated with deadwood and black woodpecker cavities. In parallel (outside Biosefair funding), we worked on wild honeybee colonies, and the main results are presented below.

TRAMETES 2 enabled:

- The collection of data from additional sites to increase the statistical power and robustness of the sampling;

- The extended use of eco-acoustic data to identify bird and bat species (and even whole communities), beyond the few species initially planned in the project;
- The search for vectors of fungi typical of cavities (notably bees), and a deeper description of cavity occupants using environmental DNA methods.

Preliminary results show that the presence of black woodpecker cavities has varying effects depending on the community considered:

- **Birds**: forest structure, especially the presence of large trees, seems to have a greater effect on communities than the mere presence of cavities. However, some species, particularly secondary cavity nesters, occur more frequently in cavity-rich areas;
- **Fungi**: fungal communities found in cavities differ from those found in downed deadwood. Some fungal groups are exclusive to cavities, highlighting their crucial role for fungal biodiversity;
- **Wild honeybees** (non-Biosefair funded work): colonies do not appear to depend on black woodpecker cavities, but rather to smaller cavities (e.g., from great spotted woodpeckers). These colonies seem viable in the medium term (at least 2–3 years).

The main perspectives of the project involve the valorization of acquired data and continuing research to better define the home range of the black woodpecker, its dispersal capacity, and its role as a vector of typical cavity fungal communities.

Results

Bird Communities

This study aimed to evaluate the influence of black woodpecker cavities (*Dryocopus martius*) on forest bird communities, using specific and acoustic indices on 68 forest plots across 5 sites in France. Contrary to our initial hypothesis, the presence of these cavities did not significantly increase community-level species richness. However, the average diameter at breast height of trees emerged as a critical factor, positively correlated with species richness across all bird groups. This result partly underscores the importance of forest maturity in supporting diverse avian communities. While cavities subtly influenced species occurrence—favoring forest specialists—the broader environmental context, particularly the presence of large trees, exerted a stronger influence on bird diversity. Species-specific responses revealed nuanced interactions with cavity presence, highlighting the need to account for habitat preferences and interspecies dynamics such as competition and predation. The study also emphasized the role of acoustic indices in providing additional insights into the soundscape and bird community composition, despite certain limitations in forest environments.

Fungal Communities

Black woodpecker cavities contribute to fungal diversity by hosting rare taxa as well as families absent from downed wood, such as *Microascaceae*. Results will be confirmed once the full set of study sites is analyzed. This demonstrates the importance of conserving these specific habitats, which increase species diversity in forest ecosystems and potentially ecosystem functions, as saprotrophic fungi

decompose organic matter and contribute to carbon cycling. At the European level, it is estimated that 20–50% of saproxylic species are threatened with extinction, representing 25% of all forest species. Among them are fungi threatened by intensive forestry and the logging of old trees. Growing attention is now being paid to fungal communities, including the development of the first national Red List of threatened fungal groups. To preserve biodiversity linked to black woodpecker cavities, especially fungal communities, it is necessary to protect these Tree-Related Microhabitats and maintain forest ecological connectivity for the species.

AI-Assisted Biodiversity Analysis

In this study, we used indicators based on scientific literature and current knowledge for bioacoustic site characterization, allowing comparisons and parameterization. However, their informative value is often limited. Thanks to the substantial volume of acoustic data collected by TRAMETES and other plot data characterizing habitats and species, a new innovative analysis framework for bioacoustic data is emerging. Using machine learning and AI algorithms, acoustic data can be decomposed and examined simultaneously across thousands of dimensions/properties. The computer autonomously learns the essential differences in this highly complex dataset, thereby developing its own discriminant properties to detect site correlations. Metadata, together with naturalists' and researchers' expertise, then allow interactive evaluation and refinement of these properties. AI thus provides an additional tool to guide management decisions through new insights. This dialogue with algorithms also refines recognition, identifies causal links, and adapts technical systems to local questions. A first interface is under development. Raw frequency data, existing bioacoustic indices, metadata (e.g., date/time, location), bird recognition from BirdNET, and other data sources have been integrated into a deep-learning pipeline.

Scientific Perspectives

The main objective of TRAMETES was to evaluate the contribution of black woodpecker cavities to forest biodiversity, focusing on birds, fungi, and wild honeybees (*Apis mellifera*). The findings are manifold and require further in-depth analysis. In summary:

- The excavation of black woodpecker cavities occurs mainly in beech-dominated forests, on trees slightly larger than average but above all in areas with fewer small trees. This confirms and quantifies previous observations of the species' biology. Future work should focus on factors influencing cavity selection, possibly using GPS trackers, now miniaturized enough for these birds;
- Bird communities are only weakly influenced by black woodpecker cavities, responding more strongly to forest structure dominated by large-diameter trees. However, forest bird communities, including some cavity-nesting species, are more frequently observed in cavity-rich areas. These results warrant further exploration;
- Ecoacoustic indices showed no clear differences between cavity and non-cavity zones, but the project yielded valuable methodological advances in

generating indices, analyzing massive ecoacoustic datasets, and developing ongoing collaborations with BirdNET;

- Environmental DNA analyses in part of the forest sites revealed that fungal diversity in cavities differs markedly from ground-level fungi, confirming their importance for overall fungal diversity. This opens perspectives on fungal dispersal between cavities and potential vectors, including the black woodpecker itself;
- The project did not demonstrate a specific link between honeybee colonies and black woodpecker cavities, unlike findings from Germany and Poland. Colonies were observed in certain forests under conditions yet to be clarified. They appear viable in the medium term, and ongoing monitoring will refine demographic insights. Genetic analyses also revealed strong hybridization with domestic lineages, raising questions about their "wild" status.

In terms of conservation status, the indicators used for its evaluation are not challenged by this study. While black woodpecker cavities, despite their relevance for both common biodiversity (birds) and functionally important groups (fungi, bees), do not yet appear as an additional conservation status indicator, they nonetheless highlight biodiversity-rich areas. Future studies should focus on other tree Tree-Related Microhabitats —or indices of Tree-Related Microhabitats diversity linked to biodiversity—to assess whether they may serve as stronger indicators of forest habitat conservation status.