



Entomologists studying tree dieback of Picea abies in Bavarian National Park  
PHOTO CREDIT: Hannelore M. Elsner

# UNDERSTANDING THE IMPACTS OF WIDESPREAD FOREST DIE-OFFS ACROSS FRANCE, GERMANY, AND CHINA

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*Metabarcoding increases the taxonomic resolution and geographic scale at which researchers can assess the impacts of climate change on insect communities in forests*

**F**orests throughout the world are suffering from an increase in the frequency and severity of droughts as well as pathogen and insect infestations. These climate-exacerbated factors are leading to tree diebacks—the progressive death of tree branches—and subsequent large-scale forest die-offs, the effects of which are not well understood. Preliminary results from our study indicate that while the number of insect species along forest die-off gradients might not be affected, their composition is changing.

CLIMTREE is an international project funded by the Belmont Forum that assesses the impact of climate-induced forest die-off on invertebrate biodiversity in highland forests in France, Germany, and China. This project aims to better understand how tree mortality and associated changes in forest composition affect biodiversity and ecosystem functions.

Our study measures changes in the insect communities along dieback and salvage-logging gradients of silver fir (*Abies alba*) forests in the French



eastern and central Pyrenees, Norway, spruce (*Picea abies*) forests in the Bavarian Forest National Park, Germany, and Yunnan pine (*Pinus yunnanensis*) forests in Yunnan province, China. We examined patterns of variation in the species diversity of flying insects collected by Malaise traps. As these passive traps can collect a large number of specimens, we analyzed samples in bulk using DNA metabarcoding. This approach uses DNA barcode reference libraries to identify species from a mixed sample using high-throughput technologies that effectively provide large amounts of DNA sequence data.

We also examined saproxylic beetles, a key functional group used as bioindicators in forest assessments of dead-wood availability. We collected these beetles using flight interception traps, and we also sampled specimens from natural history collections to build a DNA barcode reference library for the French saproxylic beetle fauna as a resource for future investigations.



*Silver fir (Abies alba) dieback in the French eastern Pyrenees.*  
PHOTO CREDIT: Carlos Lopez-Vaamonde

The preliminary results from the 56 Malaise traps deployed in the French eastern and central Pyrenees have revealed more than 3,500 OTUs (Operational Taxonomic Units, a proxy for species) belonging to 18 insect orders, with considerable change in the compositions of the species detected along the dieback gradient as well as across a 4-month period. However, results to date do not suggest significant declines in species richness over the dieback gradient.



*Members of CLIMTREE assessing the level of decline of silver fir stands in Pays de Sault (French eastern Pyrenees).*  
PHOTO CREDIT: Carlos Lopez-Vaamonde

*Polytrap flight interception trap.*  
PHOTO CREDIT: Carl Moliard



Of the 55,571 saproxylic beetles collected, about 70% were morphologically identified to one of 284 species. Similar to the flying insects collected by Malaise traps, the diversity of beetles along dieback gradients did not decline. We are now trying to use a non-destructive metabarcoding approach that involves processing the collection media to determine whether we can uncover a comparable number of species with a morphology-based sorting approach. If results



are similar, we will have a strong case for using this technique as a time-efficient alternative for biomonitoring moving forward.

Overall, there is an urgent need to obtain detailed baseline data on insect communities to quantify the impacts of climate change. By taking advantage of DNA metabarcoding approaches, our study is assessing biodiversity patterns at scales previously impossible and providing the data essential for evaluating future changes in insect communities. Our workflows are simple to use and provide an affordable, reliable, and repeatable method of assessing insect diversity in forests at a large geographical scale.

**Online:**

<https://ibol.org/barcodebulletin/research/understanding-the-impacts-of-widespread-forest-die-offs-across-france-germany-and-china/>



*Rosalia alpina* (Cerambycidae) is one of the 2,663 species of saproxylic beetles known to occur in France.

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