EUROPEAN RED LIST OF SAPROXYLIC BEETLES

The adults of *Iphthiminus italicus* are nocturnal and found under thick dead bark, dead branches or in hollow trunks of broadleaf trees. This Endangered species has a small range and is threatened by large-scale silvicultural activities and an increasing frequency of wildfires. © Herve Bouyon.

European Saproxylic Beetles

Saproxylic beetles are insects that depend on dead and decaying wood for at least part of their lifecycle, and play important ecological roles in European habitats (Speight 1989, Alexander 2008, Stokland *et al.* 2012). Together with fungi, they contribute to the break-down of deadwood and are involved in decomposition processes and the recycling of nutrients in natural ecosystems. They interact with other organisms such as mites, nematodes, bacteria and fungi, assisting in their dispersal across the landscape. They also provide an important food source for birds and mammals (Carpaneto *et al*. 2010), and some species are involved in pollination.

In Europe, there are 58 families of beetles (order Coleoptera) with nearly 29,000 species (Audisio *et al.* 2015). The exact number of saproxylic species is unknown, but a database of French saproxylic beetles includes 3,041 species (Bouget *et al.* 2008). According to expert opinion, there may be closer to 4,000 saproxylic beetle species in Europe. Dead and decaying wood offer a large variety of microhabitats, and different saproxylic species have evolved to exploit these niches, with certain species having very specific ecological requirements. Some saproxylic beetles require live old trees with cavities for their larval development, while others are dependent on trees that have recently died (Stokland *et al.* 2012). Saproxylic beetle richness depends on the quantity and quality of available dead and decaying wood in any environment with trees and woody shrubs, as well as on tree age structure, total number of trees, varying tree density, and habitat continuity (Alexander 2008, Mendez Iglesias 2009, Sverdrup-Thygeson *et al.* 2010, Bergman *et al.* 2012). The assemblage of saproxylic beetles can be influenced by the degree of sun-exposure, frequency of habitat disturbance (i.e., forest fires or clear-cutting), hedgerow management, clearance of fallen deadwood from parks, age of tree stands and presence of certain types of wood-decaying fungi, among others (Martikainen 2001, Ranius 2002, Stokland *et al.* 2012).

The long-term survival of these beetles depends on new generations of trees developing and becoming suitable for colonisation as the host trees decline and disintegrate. This means that certain beetles can be at risk even while the overall population is strong, as new host trees are not becoming available. Old and hollow trees have become increasingly scarce around the world, including in Europe, due to land management practices (Lindenmayer and Laurance 2016).

Assessment Scope

The current IUCN European Red List provides an assessment for 693 species of saproxylic beetles. In 2008, following a two-year project, a total of 436 species were assessed (Nieto and Alexander 2010). In 2017, an additional 257 species were assessed. The species selection includes obligate or presumably obligate saproxylic beetles listed in the annexes of the Habitats Directive, and full coverage of selected families and/or subfamilies[1]. All the assessments were made following the *IUCN Red List Categories and Criteria* (IUCN 2001, 2012a), which is the global standard for measuring extinction risk, and the *Guidelines*

1 The families and subfamilies comprehensively assessed were the Alleculinae, Boridae, Bostrichidae, Cerambycidae, Cerophytidae, Cetoniidae, Cucujidae, Diaperinae, Elateridae, Erotylidae, Eucnemidae, Euchiridae, Lucanidae, Mycetophagidae, Oedemeridae, Phrenapatinae, Prostomidae, Pythidae, Rhysodidae, Stenochiinae and Trogossitidae.

for Application of IUCN Red List Criteria at Regional and National Levels (IUCN 2003, 2012b).

Red List assessments were made at two regional levels: geographical Europe, and the Member States of the European Union - in the 2008 European Red List of Saproxylic Beetles, the species were assessed at the level of the then 27 Member States of the European Union (Croatia joined the European Union in 2013), while in the 2017 assessments the species were assessed at the EU 28 level. For geographic Europe, the scope is continent-wide, extending from Iceland in the west to the Urals in the east, and from Franz Josef Land in the north to the Canary Islands in the south. The Caucasus region is not included.

Threat Status

Overall, 17.9% and 21.7% of species are considered threatened[2] in Europe and in the EU 27/28, respectively. These values assume that a similar relative proportion of the Data Deficient (DD) species are likely to be threatened, and provides the best estimation of the proportion of threatened species (IUCN 2011).

For almost one quarter of the species in Europe (168 species – 24.4%), there was not enough scientific information to evaluate their risk of extinction and they were assessed as DD. In the EU 27/28, 133 species (20.4%) were also assessed as DD. When more data become available, it is possible that many of these species may also prove to be threatened. Thus, the proportion of threatened species could lie between 13.5% (if all DD species are not threatened) and 37.9% (if all DD species are threatened) for Europe, and between 17.3% and 37.7% for the EU 27/28.

In Europe, 0.7% of species have been assessed as Critically Endangered, 7.4% as Endangered and 5.4% as Vulnerable (Table 1 and Figure 1). A further 13% (89 species) are considered Near Threatened. There is a higher proportion of threatened species in the EU 27/28 (1.1% Critically Endangered, 9.3% Endangered and 6.9% Vulnerable), with 13.5% Near Threatened (Table 1 and Figure 2).

The complete list of species and their Red List status in Europe and in the EU is available as Supplementary Material[3].

Although saproxylic beetles represent an ecological grouping and are not an entire taxonomic group, by comparison, 58% of freshwater molluscs, 40% of freshwater fishes, 29% of grasshoppers, crickets and bush-crickets, 23% of amphibians, 20% of reptiles, 20% of lycopods and ferns, 17% of mammals, 16% of dragonflies, 13% of birds, 9% of butterflies and bees, 8% of aquatic plants and marine fishes, and 2% of medicinal plants are threatened, groups that were comprehensively assessed for the European region (IUCN 2015, Hochkirch *et al.* 2016, García *et al.* 2017). Additional European Red Lists assessing a selection of species showed that 22% of terrestrial molluscs, and 16% of crop wild relatives are also threatened (IUCN 2015). No other groups have yet been assessed at the European level. Thus, saproxylic beetles are one of the most threatened insect groups in Europe assessed so far, with only a smaller percentage of threatened species than grasshoppers, crickets and bush-crickets.

Table 1. Summary of numbers of saproxylic beetles within each Red List Category.

IUCN Red List Categories	No. species Europe (no. endemic species)	No. species EU (no. endemic species)
Extinct (EX)	0(0)	0(0)
Extinct in the Wild (EW)	0(0)	0(0)
Regionally Extinct (RE)	0(0)	0(0)
Critically Endangered (CR)	**5(4)**	**7(4)**
Endangered (EN)	**51(27)**	**61(20)**
Vulnerable (VU)	**37(20)**	**45(16)**
Near Threatened (NT)	89(35)	88(21)
Least Concern (LC)	338(53)	319(20)
Data Deficient (DD)	168(79)	133(50)
Total number of species assessed	**688***	**653***

*This table does not include the Not Applicable species in Europe (5 species) and/or the EU (2 species) (species of marginal occurrence). For the EU assessments, the Not Evaluated species (species which do not occur in the EU) are also excluded.

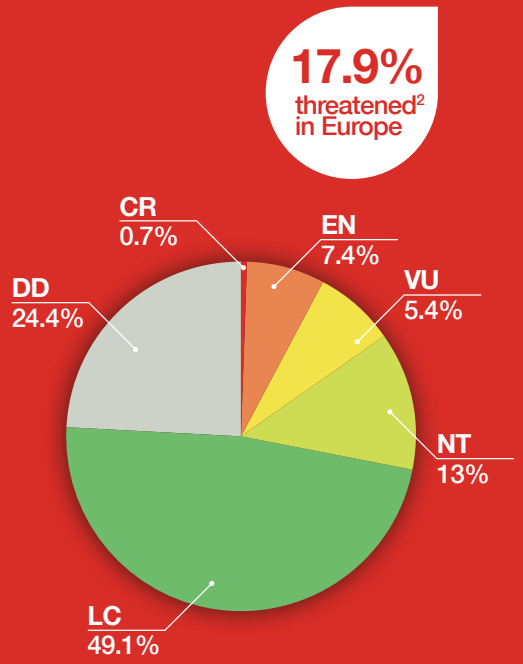


Figure 1. IUCN Red List status of saproxylic beetles in Europe.

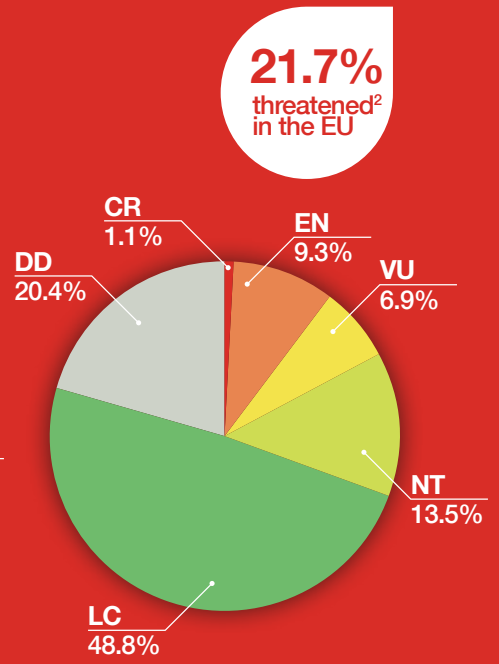


Figure 2. IUCN Red List status of saproxylic beetles in the EU.

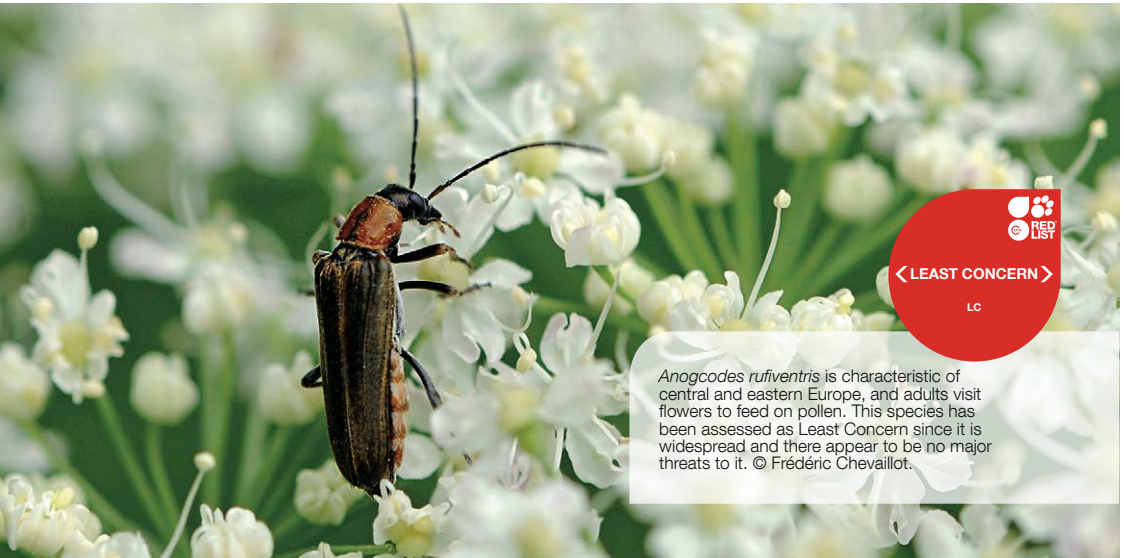
2 This percentage is the mid-point value, which represents the best estimate of extinction risk and is calculated as follows: [(CR+EN+VU) / (Assessed-DD)] (IUCN 2011).
3 Supplementary Material available at: http://www.iucnredlist.org/initiatives/europe/publications

Major Threats

An overview of the major threats affecting European saproxylic beetles is shown in Figure 3. Logging, tree loss and wood harvesting are by far the greatest threats to both threatened and non-threatened saproxylic beetles, affecting more than half the species (54.5%, 375 species), including 76 threatened species. Tree loss refers to the threats of tree age structure gaps, loss of ancient and veteran trees, degraded landscapes that are unfriendly to tree growth, and indiscriminate felling for spurious health and safety reasons. This highlights the importance of European forests and other landscapes with trees for the continued survival of these deadwood-dependent species.

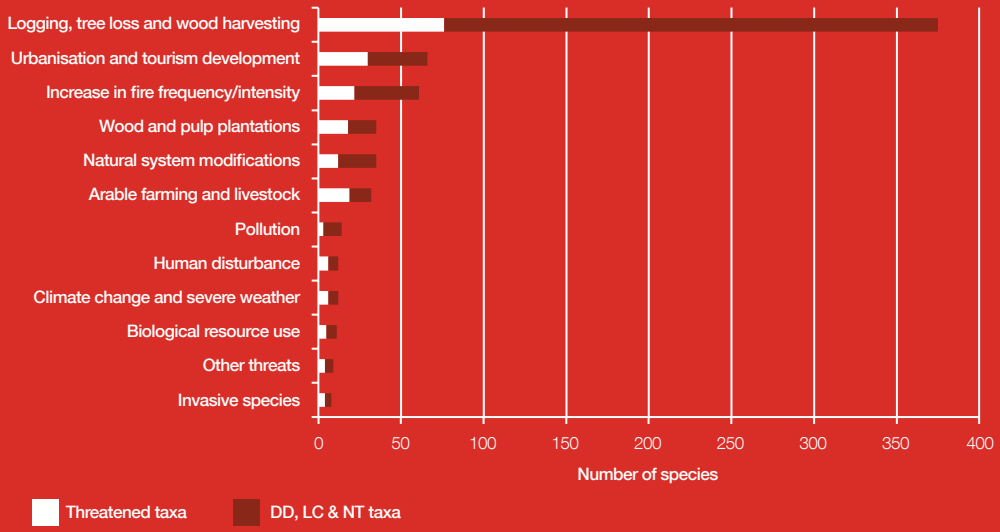
A large number of saproxylic beetles are dependent on ancient and veteran trees, especially those species developing in decaying heartwood and accumulations of wood mould in the resulting cavities. In Europe, large hollow trees have become increasingly rare due to land management procedures (e.g., logging, felling for health and safety reasons). Thus, the populations of saproxylic organisms associated with this microhabitat are undergoing a decline (Johannesson and Ek 2005). This decline is of special importance for several species of beetles belonging to the Elateridae, Scarabaeidae, Staphylinidae and Tenebrionidae, since these are the largest and most ecologically important insect families living in this microhabitat (Carpaneto *et al.* 2015).

Throughout Europe, the presence of deadwood has historically been considered as a sign of neglect and poor forest management. As a result, some forests are still "cleaned" of fallen logs and standing dead trees, which can lead to the disappearance of saproxylic beetles from the area. Old trees in urban environments are also often cut down due to public safety concerns (La Fauci *et al.* 2006). However, in many countries the importance of deadwood is being increasingly acknowledged and best practice management now highlights the importance of having landscapes and forests with a diverse tree age structure, native tree species, and a sufficient number of mature and decaying old trees in different stages of aging. Ancient tree inventory projects are taking place in several European countries, such as the UK, Italy and Romania (Woodland Trust 2017, Zapponi *et al.* 2017, Arbori remarcabili 2017).



Anogcodes rufiventris is characteristic of central and eastern Europe, and adults visit flowers to feed on pollen. This species has been assessed as Least Concern since it is widespread and there appear to be no major threats to it. © Frédéric Chevaillot.

Figure 3. Major threats to saproxylic beetles in Europe.



Recruitment of new trees to replace disappearing veteran trees is very low (Lindenmayer and Laurance 2016). Thus, despite a current assessment of Least Concern, certain species require urgent conservation action. Even if the current populations are still strong, halting the decline of European veteran trees and promoting the recruitment of new trees - which will take hundreds of years to grow - is critical to ensure their long-term survival.

In the EU, the outstanding conservation value of semi-open wood pasture systems with veteran trees is currently neither specifically recognised in the Common Agricultural Policy, nor in annex I of the Habitats Directive. Even within Natura 2000 sites specifically designated for wood pastures or saproxylic beetles, eligibility rules for CAP payments are promoting management practises that are leading to a transformation of wood pastures into either woodland or grassland, thereby destroying the essential vegetation mosaic beetles require (Alexander 2016).

Urbanisation and tourism development is the second most important threat, affecting 9.6% of saproxylic beetles (66 species), of which 30 are threatened. Habitat loss due to infrastructure construction is particularly important in the Mediterranean coastal regions due to tourism development. New motorways also pose a significant threat, since they lead to an increase in the fragmentation of tree landscapes.

An increase in the frequency and intensity of wildfires in the Mediterranean region, as well as wood and pulp plantations are the next most important threats, impacting 61 and 35 species, respectively. Other threats include arable farming, pollution and invasive alien species (Figure 3). Climate change is also a potential major threat, but assessment of impacts on saproxylic beetles is extremely challenging and there is still limited understanding and appreciation of the issue. The threats for a total of 182 saproxylic beetles remain unknown, reflecting the need for more field work and monitoring.

Diaperis boleti is a widely distributed species that lives and grows in various bracket fungi, often in colonies of numerous individuals. This species has been assessed as Least Concern since it seems to be abundant throughout its distribution area. © Frédéric Chevaillot.

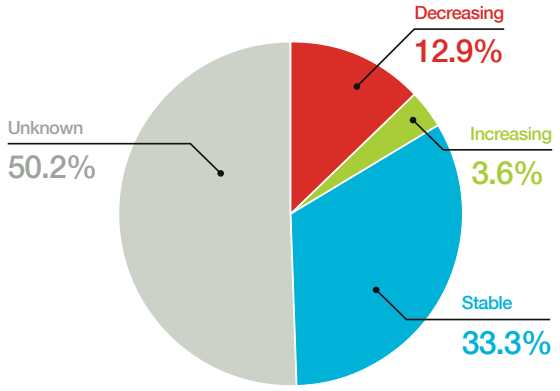
THE PRINCIPAL DRIVER OF DECLINE AND LOCAL EXTINCTION IS THE LOSS OF VETERAN TREES ACROSS EUROPE

Population Trends

Data are presently very poor on the population trends of many species, and increased efforts are needed in monitoring European saproxylic beetles. The population trend provides key information when assessing the Red List status of a species. Therefore, as part of the Red List process, the trend of each species' overall population was assessed as either declining, stable, increasing or unknown.

In Europe, 12.9% (89 species) of saproxylic beetle populations are thought to be in decline, while 33.3% are considered stable (229 species), and 3.6% (25 species) are increasing (Figure 4). For half the species (345 species), the population trend is unknown, and 14.8% of these (51 species) are threatened.

Figure 4. Population trends of European saproxylic beetles.



Spatial Distribution Patterns

The spatial distribution patterns of saproxylic beetles in Europe are shown in Figures 5 to 8. The intermediate latitudes of central Europe clearly stand out as areas of high species richness (Figure 5). Biodiversity hotspots seem to be located in mountainous areas such as the Pyrenees, Alps and Carpathians. The richness of endemic species is shown in Figure 6 and shows somewhat similar patterns to the overall species diversity.

The Mediterranean and Macaronesian islands have many range-restricted endemic saproxylic beetles, although these regions do not necessarily show up on the endemic species richness map since typically each particular island will only have one or a few endemic species.

Limoniscus violaceus has become extinct in parts of its European range and is declining in many countries. This Endangered species depends on veteran trees and the larvae develop in tree cavities containing wood mould.
© Nicolas Gouix.

Figure 5. Species richness of European saproxylic beetles.

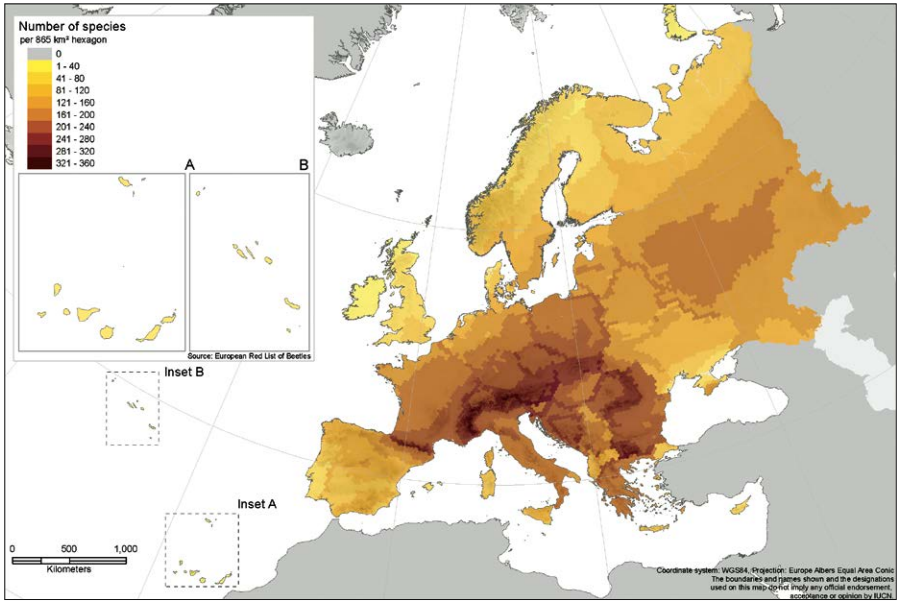


Figure 6. Distribution of endemic saproxylic beetle species in Europe.

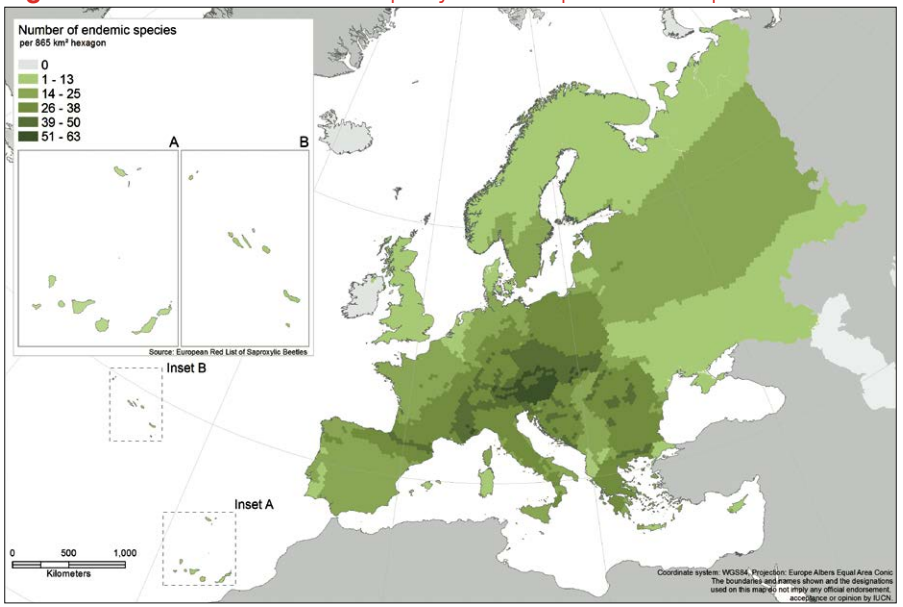


Figure 7. Distribution of threatened saproxylic beetles in Europe.

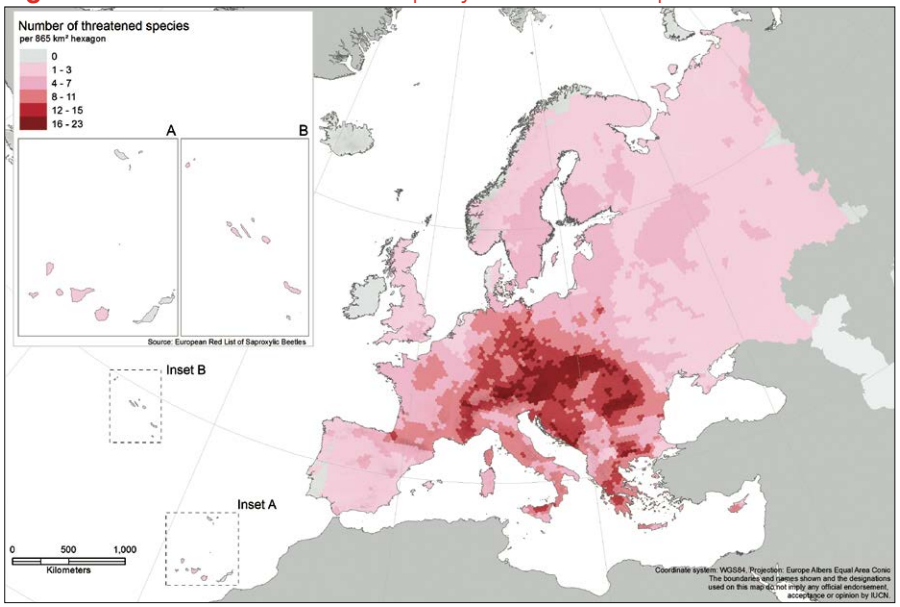
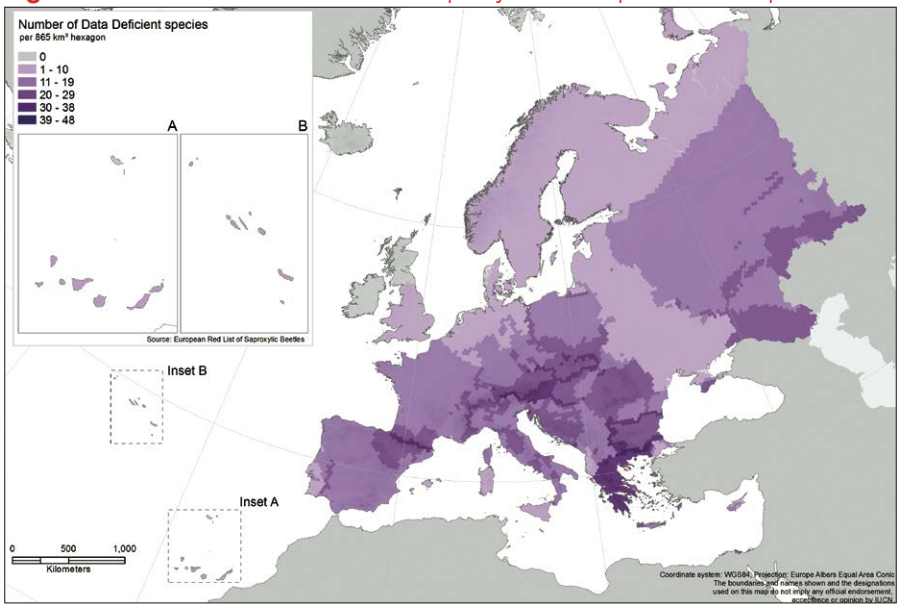


Figure 8. Distribution of Data Deficient saproxylic beetle species in Europe.



The distribution of threatened species is shown in Figure 7, and shows that the greatest concentrations of threatened saproxylic beetle species are found in central and eastern Europe, with Hungary and surrounding countries having a high number of threatened species. The lack of threatened species in other regions of Europe can be explained by the fact that species found in these areas are quite widespread, due to the lack of biogeographical peculiarities in certain regions, and/or due to the lack of suitable habitat in areas dominated by arable agriculture.

The distribution of Data Deficient species is shown in Figure 8, and shows a very similar pattern to the general saproxylic beetle richness (Figure 5), with a particularly high number of Data Deficient species present in the Balkan Peninsula and in European Russia. In the Balkan Peninsula, some species have only been recently described or recorded, and there is no information to elucidate their trends and threats. In addition, the distribution of Data Deficient species also reflects a general lack of research or very limited knowledge about species' ecology as a result of the small number of saproxylic ecologists in Europe. Finally, some species are only known from historical records and from a single locality, while the taxonomic status of others remains a matter of discussion.

Cortodera humeralis is found in broadleaf temperate forests in central and southern Europe. This Least Concern species lives in various woody debris on the soil of deciduous forests and there are no major threats to it. © Hervé Bouyon.

Conservation Action

From a nature conservation point of view, the tree population, its age and continuation, as well as its management history are the key to the resilience of saproxylic beetle populations. To promote maximum species richness and population viability for different types of saproxylic beetles, each square kilometre of land should contain some diversity in the age of the trees present - including some saplings, young trees, mature trees, and especially veteran and ancient trees, standing dead trees, fallen tree trunks and stumps.

Several species of saproxylic beetles have very small and isolated subpopulations, and in those cases priority should be given to places with a larger surface area in order to prevent genetic bottlenecks. Ecological corridors should also be considered to promote exchange between isolated subpopulations.

In the past 20 years, the amount of deadwood in European forests has continuously increased as a consequence of the increasing interest in biodiversity conservation in silvicultural practices and forest policies (FOREST EUROPE 2015). However, veteran trees in other European landscapes (notably in wood pasture systems, parks, and tree avenues) remain at high risk.

In urban areas, certain measures are recommended to maximise the conservation of saproxylic beetles while ensuring public safety. These measures include minimising cutting of veteran trees as much as possible, and leaving trunks (monoliths) standing (Lonsdale 2013). Other recommendations include leaving large branches and trunks on the ground after they have been cut; reducing cuts of secondary tree branches in order to retain canopy cover and maintain optimal microclimatic conditions of tree holes; and removing trash left in hollows by people, among others (Carpaneto *et al.* 2010). Guidelines have already been developed in the UK for suitable risk management of trees (National Tree Safety Group 2011), and a similar EU-wide framework could encourage Member States to follow best practice procedures instead of allowing over-the-top Health and Safety felling.

Additionally, guidelines on good management practices for veteran trees have been developed and should be consulted by relevant stakeholders before carrying out any activities that may have negative impacts on these trees (Read 2000, Lonsdale 2013). These documents provide a wealth of guidance based on the practical experiences of a large number of experts. They emphasise the iconic qualities of veteran and ancient trees, and how these might be maintained into the future.

The Forest Stewardship Council (FSC) promotes the responsible management of the world's forests, and many European and EU countries have FSC-certified areas. These areas must ensure the protection of threatened species in order to comply with the FSC certification requirements, and can therefore play an important role in saproxylic beetle conservation.

LIFE is the EU's financial instrument supporting nature conservation in projects throughout the EU and can therefore provide an important tool for saproxylic beetle conservation in Europe. For instance, the LIFE project on "Monitoring of saproxylic beetles and other insects protected in the European Union" developed and field-tested monitoring methodologies in Italy (Campanaro *et al.* 2017). The results of this project should be applicable across the European ranges of the species concerned.

There is a clear need to stimulate and support more research, monitoring and conservation of saproxylic beetle species across Europe. The IUCN European Red List can be used to help prioritize sites and species for conservation action.

Isomira hypocrita is only found in Europe, and it inhabits montane systems across central and southern Europe. This species was assessed as Data Deficient due to the lack of data on its population size and trend, ecology and threats. © Hervé Bouyon.

Key Recommendations

Policy

- The IUCN European Red List should be used to inform nature and biodiversity policies to improve the status of threatened species, and should be revised at regular intervals of ten years, and whenever new data become available.
- All remaining European saproxylic beetles should be assessed on the IUCN European Red List in order to have a full understanding of the status of this ecological group.
- Measures should be promoted at the EU level to ensure a minimum amount of trees/deadwood is allowed to persist in European landscapes that would ensure the survival of saproxylic beetle populations.
- The Common Agricultural Policy should promote appropriate management of wood pasture habitats containing veteran trees across Europe.
- Recommendations No R.(88) 11[4] and R.(88) 10[5] of the Council of Europe to Member States on i) ancient natural and semi-natural woodlands, and ii) protection of saproxylic organisms and their biotopes should be fully implemented.
- Measures should be put in place to prevent illegal logging and ensure control of wood collecting.
- Guidance should be developed on best practices for saproxylic beetle conservation in Natura 2000 sites and FCS-certified areas in Europe.
- Guidance should be developed on suitable management of risk in trees to prevent over-the-top felling of veteran trees in urban landscapes.

Species and habitat conservation

- Conservation strategies for European saproxylic beetles with the highest risk of extinction should be developed and implemented.
- Best habitat management practices for European saproxylic beetles should be broadly adopted and relevant stakeholders should be made more aware of the available sources of information.
- Saproxylic beetle inventories in Natura 2000 sites and other protected areas should be made to identify priority species in order to develop strategies for their protection.
- Veteran trees should be preserved throughout Europe, in forests, pastureland, orchards, and urban areas.
- Public awareness should be raised about the importance of fallen and decaying trees for saproxylic beetle conservation, as well as of veteran trees in the landscape.
- Inventories of ancient and veteran trees should be developed for each European country, in order to ensure these trees are protected in all landscapes.
- Habitat fragmentation should be reduced by creating ecological networks and corridors.

Research

- Specific research on those species that have not been recently recorded in Europe or have been assessed as Data Deficient should be conducted to clarify their status.
- The effects of less well understood threats (e.g., climate change) on saproxylic beetles should be studied.
- Effective monitoring tools and improved research efforts on saproxylic beetle species should be developed and promoted, particularly in the Natura 2000 network, in order to understand population trends and the impacts of implemented actions.
- Further research is needed to identify old growth habitats in the cultural landscapes of Europe.

Clamoris crenatus is very localized and rare, and is only found in the western Mediterranean Basin. This Vulnerable species is threatened by large scale agricultural maize production which is destroying large forest areas. © Hervé Bouyon.

4 Available at: https://wcd.coe.int/com.instranet.InstraServlet?command=com.instranet.CmdBlobGet&InstranetImage=609031&SecMode=1&DocId=697380&Usage=2

5 Available at: https://wcd.coe.int/com.instranet.InstraServlet?command=com.instranet.CmdBlobGet&InstranetImage=609025&SecMode=1&DocId=697370&Usage=2

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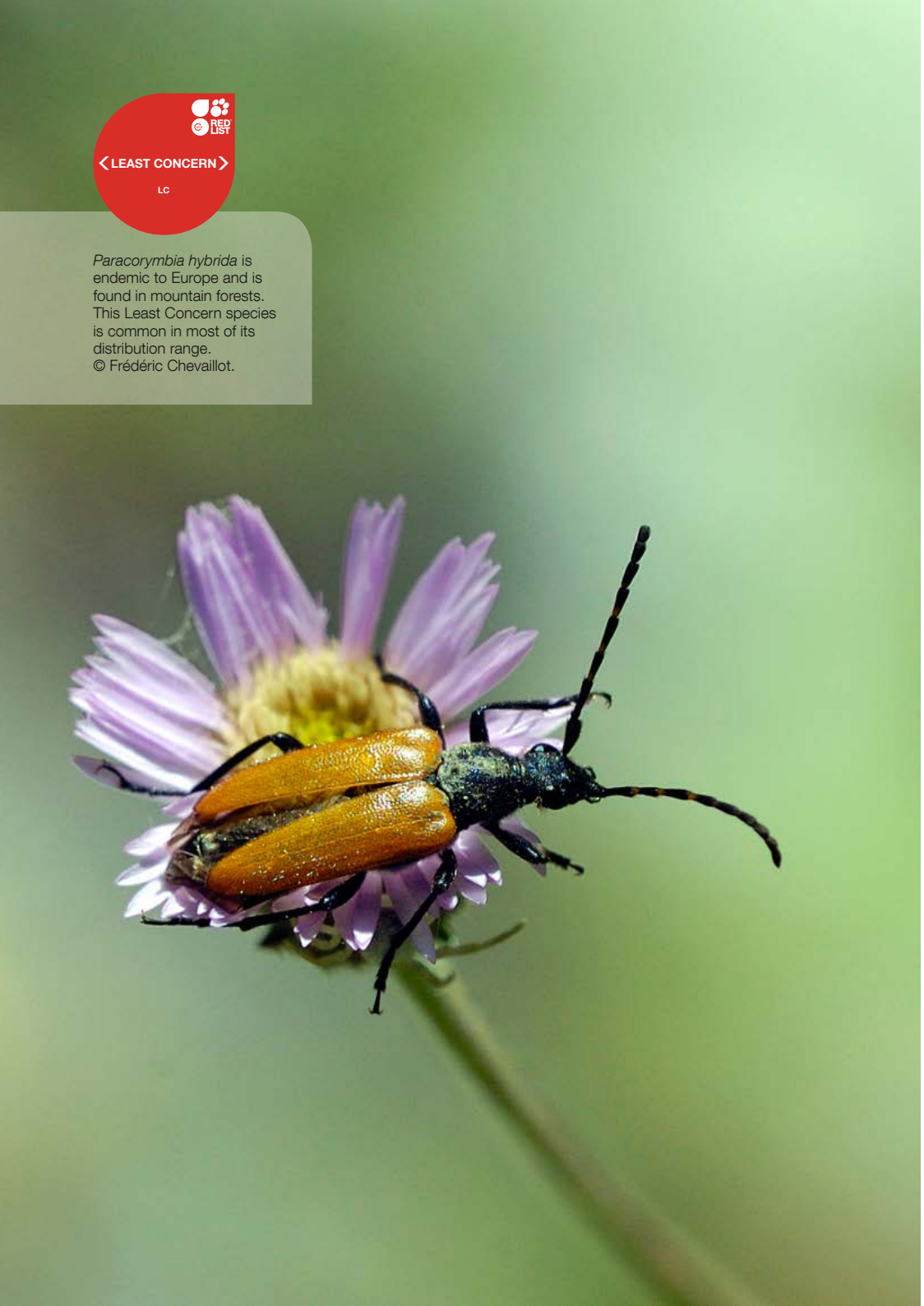

Paracorymbia hybrida is endemic to Europe and is found in mountain forests. This Least Concern species is common in most of its distribution range.
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 This brochure has been prepared by IUCN (International Union for Conservation of Nature) as a deliverable of the LIFE European Red Lists project (LIFE14 PRE/BE/000001).

Project Title: Establishing a European Red List of Bryophytes, Pteridophytes, Saproxylic Beetles, Terrestrial Molluscs and Vascular Plants (LIFE European Red Lists; LIFE14 PRE/BE/000001).

Project duration: May 2015 to December 2018. Project's total costs: 1,166,667 EUR.

Contribution of the LIFE Programme: 700,000 EUR.

Co-financers of the project: National Parks and Wildlife Service, Republic of Ireland; Ministry of Economic Affairs, Department of Nature & Biodiversity (Ministerie van Economische Zaken, Directie Natuur & Biodiversiteit), the Netherlands; Council of Europe; Office federal de l 'Environment, Switzerland; Swedish Environmental Protection Agency (Naturvardsverket), Sweden; British Entomological Society, United Kingdom; Ministry of Sustainable Development and Infrastructure, Government of the Grand-Duché of Luxembourg.

The LIFE Programme (http://ec.europa.eu/environment/life/index.htm) is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental, nature conservation and climate policy and legislation by co-financing projects with European added value.

It is available online at http://ec.europa.eu/environment/nature/conservation/species/redlist and http://www.iucnredlist.org/initiatives/europe

Published by: IUCN, Brussels, Belgium.

Citation: Cálix, M., Alexander, K.N.A., Nieto, A., Dodelin, B., Soldati, F., Telnov, D., Vazquez-Albalate, X., Aleksandrowicz, O., Audisio, P., Istrate, P., Jansson, N., Legakis, A., Liberto, A., Makris, C., Merkl, O., Mugerwa Pettersson, R., Schlaghamersky, J., Bologna, M.A., Brustel, H., Buse, J., Novák, V. and Purchart, L. 2018. European Red List of Saproxylic Beetles. Brussels, Belgium: IUCN.
Available at: http://www.iucnredlist.org/initiatives/europe/publications

Design and layout: Imre Sebestyén jr. / UNITgraphics.com

Anastrangalia sanguinolenta is widespread across Europe and is found in coniferous forests from the boreal zone to lowland plantations. This species has been assessed as Least Concern since it is very common and the population is increasing. © Frédéric Chevaillot.

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