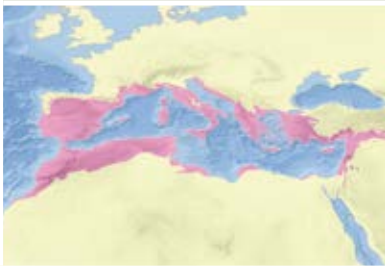
THE CONSERVATION STATUS AND DISTRIBUTION OF MEDITERRANEAN SAPROXYLIC BEETLES

Nieves García, Catherine Numa, Luca Bartolozzi, Hervé Brustel, Jörn Buse, Margherita Norbiato, José Ignacio Recalde, José Luis Zapata, Benoit Dodelin, Elisa Alcázar, Violeta Barrios, Antonio Verdugo, Paolo Audisio, Estefanía Micó, José Carlos Otero, Pablo Bahillo, Amador Viñolas, Lionel Valladares, Marcos Méndez, Salwa El Antry and Eduardo Galante

MEDITERRANEAN



The IUCN Red List of Threatened Species™ – Regional Assessment

SSC Species Survival Commission

MAVA

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The IUCN Red List of Threatened Species™ – Regional Assessment

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Cover photo: Female of the jewel beetle *Buprestis splendens* walking on a dry trunk of Bosnian pine *Pinus heldreichii* in Greece. This species lives in relict old growth pine forests and is listed as Vulnerable in the Mediterranean due to logging, forest fires and climate change. ©Nikola Rahme.

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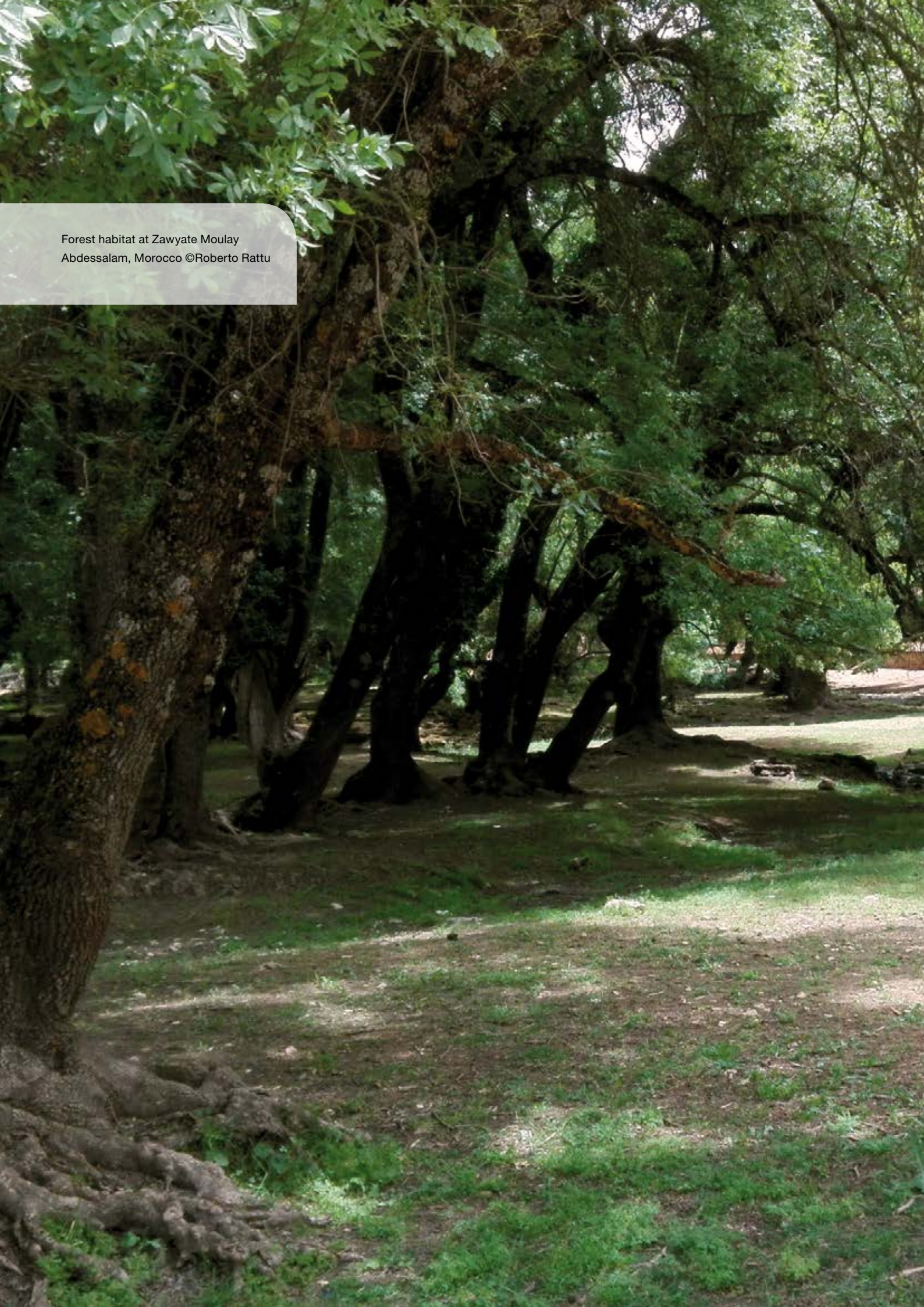

Forest habitat at Zawyate Moulay Abdessalam, Morocco ©Roberto Rattu

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Foreword

The rich biodiversity and dynamic ecosystems found in the Mediterranean region partially result from thousands of years of human influence. The current changing environment and conditions urge us to understand how plants and animals of the area are coping, what are the main threats affecting their survival, and which conservation measures should be implemented. In this context, the IUCN Red List of Threatened Species represents an important tool to monitor the conservation status of biodiversity.

By assessing the conservation status of species at the Mediterranean level, we are much better equipped to identify regional conservation priorities as well as to guide and inform regional policy. The IUCN Red List of Threatened Species helps monitor the progress towards achieving the global Sustainable Development Goals, in particular those which seek to halt marine and terrestrial biodiversity loss (SDGs 14 and 15).

The IUCN Mediterranean Red List is a regional initiative focused on assessing the extinction risk of species in the Mediterranean basin. Since 2006, more than 6.000 species have been assessed, covering a wide variety of marine and terrestrial taxonomic groups, namely plants, coralligenous, freshwater and marine fishes, amphibians, reptiles, birds, mammals, freshwater crustacean and molluscs, odonata, butterflies, and beetles.

Saproxylic beetles are part of a complex and diverse set of organisms which are fundamental for nutrient cycling in forests and woodlands. The Status and Distribution of Mediterranean Saproxylics is the latest addition to the growing database of species assessed at the Mediterranean level, and a remarkable contribution towards making the Mediterranean Red List more representative of the overall Mediterranean biodiversity.

The assessment of 320 species of obligate saproxylic beetles, which are endemic or almost endemic to the region, reveals that 19% of the assessed species are threatened with extinction. The intensification of forestry and agriculture have resulted in a decline of suitable habitat, and many saproxylic insects have consequently become rare or threatened with extinction.

It is important to note that, for more than 40% of the species, not enough data is currently available to evaluate their extinction risk, and they have been classified as Data Deficient. Regional cooperation among relevant actors from Mediterranean countries is urgently needed in order to improve the knowledge on the status of saproxylic beetle species, and to minimize their threats throughout the Mediterranean basin. Further research on insects living in trees will enhance our knowledge of the functioning of ecosystems in wooded landscapes and open possibilities to utilise them in identifying key sites for nature conservation or for monitoring the sustainability of forest management.

I hope this publication will serve as an instrument for conservation of forest biodiversity in the Mediterranean region, and that it will inspire people to keep learning and caring for these fascinating creatures.

Ana Nieto
Head Species Conservation Action,
IUCN Global Species Programme

Foreword

The Mediterranean is a region rich and diverse in natural and cultural heritage. It is the second largest of 34 biodiversity hotspots in the world, extending through more than 22 countries. Mediterranean landscapes have been changed by human activities in such a manner that the region is covered with a mosaic of natural and semi natural areas surrounding growing urbanized areas. Better knowledge about biodiversity represents the first step toward driving change and achieving conservation efforts on the ground. IUCN is a leading global organization which influences policy, undertakes conservation planning, and guides action on the ground. By combining credible knowledge, standards and tools with a mobilized network of partners, IUCN Centre for Mediterranean Cooperation supports improved policies and action on the ground, particularly working on behalf of IUCN members across the region.

The Mediterranean Red Lists are an important tool to understand and communicate the status of species in the region, helping to make conservation of threatened species more achievable. Because the Red Lists not only provide information about the species status in the region, but also provide insights for the better understanding of their ecosystems and other species they depend on, they are an important practical mechanism for implementing national and regional strategies for biodiversity conservation of the Convention for Biological Diversity. The information collected through the Mediterranean Red List assessment contributes to Aichi Targets, in particular Target 12, which calls for the prevention and improvement of the conservation status on known threatened species by 2020.

The Mediterranean landscape is characterized by a high diversity of species and ecosystems, which depend on saproxylic fauna to maintain a healthy function. These include forests, maquis, garrigues, pastures, and coastal areas. The high diversity of these organisms make them one of the main components of the forest fauna. They are involved in important ecosystem services, such as breaking down deadwood and recycling nutrients, which are key for maintaining the ecosystem and economy of the region. Habitat loss due to forestry exploitation and traditional management practices for example, dead wood removal and nomadic overgrazing, are the current main threats faced by saproxylic beetles in the Mediterranean. This report presents a review of the conservation status of 320 species of obligate saproxylic beetles inhabiting the area. Most of these species (195 species) are only found within the borders of the region (endemic), which is one of the reasons why their conservation is so important.

Since its establishment in 2001, one of the main roles of IUCN Mediterranean office has been to assess the regional conservation status of Mediterranean biodiversity. The Red List of Saproxylic beetles is the 12th in the series. The results presented here make clear the need for better management schemes, and provide options and recommendations to address these challenges. I hope this work will help to achieve these aims, while advancing recovery plans and developing frameworks to prioritise species and sites.

Going forward, we plan to continue working in partnership through our diverse culture heritage in order to address the many challenges related to conserving Mediterranean forest biodiversity.

Antonio Troya

DIRECTOR

IUCN Centre for Mediterranean Cooperation

LEAST CONCERN

LC

Protaetia opaca. Adults on a *Cynara* sp. flower. Their hard shell protects them from bee stings while they eat nectar, honey or flowers. Listed as Least Concern. ©Antonio Verdugo

EXECUTIVE SUMMARY

AIM

The Mediterranean Red List assessment is a review of the conservation status at regional level of approximately 6,000 species of animals and plants. Following the IUCN Red List Categories and Criteria, it identifies those species - amphibians, mammals, reptiles, fishes, insects (butterflies, dragonflies and beetles), molluscs, corals, and plants - threatened with extinction at the regional level to guide appropriate conservation actions for improving their status. This report summarizes the results for a key group of Mediterranean biodiversity: saproxylic beetles.

SCOPE

The geographical scope followed for this assessment is the Mediterranean region according to the Mediterranean Basin Biodiversity Hotspot delineated by Mittermeier *et al.* (2004), with the exception of the Macaronesian islands, which have not been included in this study. All the obligate saproxylic beetles endemic or almost endemic to the Mediterranean region – 320 species and 1 subspecies – are included.

CONSERVATION STATUS ASSESSMENT

The species conservation status was assessed using the reference document *IUCN Red List Categories and Criteria* (IUCN 2012a) and follows the *Guidelines for application of IUCN Red List Criteria at regional levels* (IUCN 2012b). The list of taxa was compiled with the support of a network of 21 relevant regional experts, and reviewed during a 2015 workshop in Alicante (Spain) and followed up through correspondence until completion. All individual taxon assessments have been published on the IUCN Red List website: *http://www.iucnredlist.org/initiatives/mediterranean*.

MEDITERRANEAN SAPROXYLIC BEETLES

Sixty-three per cent of 507 species of obligate saproxylic beetles inhabiting the Mediterranean have the majority of their distribution range – at least 75% - within the borders of the region (320 species and 2 subspecies); 196 of which are endemic as they cannot be found nowhere else in the world. An additional number of species are excluded from this assessment, including 187 taxa with less than 25% of their distribution range within the region, and two non-natives, *Apate monachus and Xystrocera globosa*.

RESULTS

Overall, 61 species of the 320 saproxylic beetles evaluated are threatened in the Mediterranean region, 29 species are Near Threatened and 131 species are Data Deficient. Assuming that a similar relative proportion of the Data Deficient (DD) species are likely to be threatened, it is estimated that 32% of saproxylics are threatened in the Mediterranean. The percentage of threatened species is similar to other groups assessed in the region such as amphibians (30%) and reptiles (22%) but higher than better known groups like mammals (13%), dragonflies (18%) and butterflies (5%).

Saproxylic beetles are more at risk in the Mediterranean than in Europe, where 14% of the assessed species are threatened (Calix *et al.* 2018), compared to the Mediterranean 32 found through the present assessment.

The Mediterranean region also holds an outstanding level of endemism in terms of saproxylic beetles, with 194 species and 2 subspecies (38%) found nowhere else in the world; one-quarter (25%, 49 species) of these endemics are threatened with extinction.

A preliminary analysis of the spatial patterns highlights a hotspot of endemic threatened saproxylic beetles in the eastern part of the Mediterranean, along the coast of Turkey, the Taurus Mountains, and Levant, which also stands out as being one of the areas with the highest number of species classified as Data Deficient. The Tell Atlas region in northern Algeria and Tunisia has also been identified as a hotspot for endemic species.

Most of the threatened species are confined to the Taurus Mountains in the Turkish province of Mersin, the Calabria region in southern Italy, Lebanon and Mediterranean Syria in the Middle East, the High and Tell Atlas mountains in Morocco and Algeria, and the islands of Sardinia and Corsica. Furthermore, in many Mediterranean countries there is a significant lack of information regarding distribution, population size, and trends, especially in northern Africa and the eastern Mediterranean.

Habitat loss due to forestry exploitation and traditional management practices for example, dead wood removal and nomadic overgrazing, are the current main threats to saproxylic beetles in the Mediterranean. Additional major threats are forest fires, residential and commercial development, and climate change.

LEAST CONCERN

LC

Protaetia affinis. Listed as Least Concern. Photo © Nikola Rahme.

EXECUTIVE SUMMARY

CONCLUSIONS AND RECOMMENDATIONS

Despite their key role in the ecosystem´s health and food chain, saproxylic beetles are still largely misunderstood and the current information gaps on these species´ population status, trends, and distribution are a reflection on how little we still know about them. Overall, the current impacts derived from the generalized mismanagement of forest resources that traditionally focuse on removing dead wood, particularly in mature forested areas, lead to degradation and disappearance of this, the preferred and in many cases indispensable, habitat for the development of the immature stages of the species (larvae). The common risk of forest fires in the Mediterranean landscape represent another major concern to these species survival. Further conservation measures recommended to improve its status include:

- Changes in traditional habitat management strategies and policy implementation to reinforce the importance of dead wood for crucial stages of the life cycle of saproxylic beetles.
- Improvement of forest management through increasing the importance of native tree species also in commercial forestry, enriching pine plantations with broadleaved tree species and allowing trees for natural aging within the stands.
- Reinforce field research to increase knowledge on the distribution, population, and natural history of this easily under recorded species, particularly those taxa listed as Data Deficient.
- In order to stop further decline in the Mediterranean environments, threatened species should be included in the national and regional catalogues and their protection enforced through policies designating area and habitat protection, with particular emphasis on endemic threatened taxa and Key Biodiversity Areas.
- Increase the funding mechanisms for example, EU Life programme to conservation projects on threatened saproxylic species included in the IUCN Red List.
- Strengthen regional collaboration between Mediterranean scientists specialized in this functional group of beetles or the taxonomic groups involved so that information gaps can be filled in the countries where least is known and therefore a more comprehensive picture of the status of these species can be drawn at the national, regional and global level.
- Regularly update the information with new records, as these become available, on native Mediterranean saproxylic beetles, also through the collaboration between professional and amateurs engaged in entomology, including the national and local entomological societies.
- Raise public awareness on the importance of dead wood for saproxylic beetles in the Mediterranean forests to conserve healthy and balanced ecosystems, and the services they provide.

KEY MESSAGES:

➜ **Saproxylic beetles are one of the main components of forest fauna.** They are involved in important ecosystem services, such as breaking down deadwood and recycling nutrients, pollination; and contribute to insect biomass in forests, being available for higher trophic levels such as breeding birds, bats and other insectivore vertebrates.

➜ **Species information remains very limited for many saproxylic species in the region: 41% of the species were assessed as Data Deficient (DD).** There is an urgent need for collaborative field research and monitoring. Given the high levels of threat across the Mediterranean region, it is reasonable to expect that further research and sampling might reveal many of these DD species to also be threatened.

➜ **Saproxylic beetles diversity in the Mediterranean region are highly dependent on heterogeneity of forests and trees, on the variety of species, ages and availability of fallen and decaying trees.** Improvement of forest, trees and wood management in natural, agricultural and urban landscapes will be key to ensure wood associated biodiversity maintaining future healthy ecosystems.

Chapter 1. Introduction

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1.4. Objectives of the regional assessment 5

This report presents an overview of the regional conservation status of saproxylic beetles in the Mediterranean region. The IUCN Centre for Mediterranean Cooperation, in collaboration with the IUCN Species Programme and a key group of regional experts, presents the overall results and findings of the assessment. The objective of this report is to provide a baseline of the status of this group of beetles in the region, and to help facilitate the development of priority research, conservation, and management actions for them. It compiles specialized information about their distribution and natural history, and highlights those species which have been found to be of greatest conservation concern as well as the ones with very little to no information, for which more research and awareness is urgently needed.

1.1 The Mediterranean region

The Mediterranean region (Figure 1) comprises 24 diverse countries historically connected though a common sea. Located at the intersection of three continents, its limits stretch east to west from the shores of the Levant to the Iberian Peninsula, and north to south from the southern coast of Europe to the northern coast of Africa, including around five thousand islands scattered around the Mediterranean Sea (UNEP/MAP 2012).

Hot dry summers, humid and cool winters, and a succession of dry and flash-flood periods are common characteristics to the Mediterranean climate (UNEP/MAP 2013). Its varied topography is a changing landscape of high mountains, rocky shores, scrubland, semi-arid steppes, coastal wetlands, sandy beaches, and a myriad of islands which have been shaped by centuries of human-induced activities, such as forest and scrub fires, clearances, livestock grazing, and cultivation (Sundseth 2009). These environmental and anthropogenic conditions have profoundly influenced the vegetation and wildlife of this unique region considered one of the world's richest places in terms of biodiversity (Myers *et al.* 2000).

The outstanding diversity of the Mediterranean region comprises about one-third of endemic species - they are unique to the Mediterranean and found nowhere else in the world - including 60% of freshwater molluscs, almost half of amphibians and freshwater fishes, 41% of reptiles, 21% of butterflies, 13% of dragonflies, 12% of mammals and 2% of birds (Critical Ecosystem Partnership Fund 2017). Also, underwater, the Mediterranean Sea´s biodiversity is exceptionally rich, with 14% of the marine fish being endemic (Cavanagh and Gibson 2007, Abdul Malak *et al.* 2011) and up to 18% of the world's macroscopic marine species being found there, of which 25 to 30% are endemic (Bianchi and Morri 2000). The Mediterranean's importance for wildlife is not limited to the richness or uniqueness of its resident fauna and flora, as millions of migratory birds from the far reaches of Europe and Africa also use Mediterranean wetlands and other habitats as stopover, wintering or breeding sites (Cuttelod *et al.* 2008).

The region is also home to a steadily growing human population of around 480 million people (European Environment Agency 2014) from a wide variety of countries and cultures, and a mayor tourist destination projected to reach 637 million visitors by 2025 – the majority of whom visit the coastal zone (Plan Bleu 2012). Both population growth and tourism have caused the loss of wildlife-rich habitats by increasing urbanization and tourism infrastructure development and have had a major socio-economic impact on large parts of the region (Numa *et al.* 2016).

Considerable economic disparities exist within the region as some people depend heavily on natural resources. The loss of biodiversity is undermining the potential for economic growth, affecting the security of populations (food, health, etc.) and limiting their options. On the other hand, economic development increases the pressures on the environment and hence conservation challenges and options in the region are driven by these economic inequities (Cuttelod *et al.* 2008).

Particularly, a massive change has taken place in agricultural practices across the Mediterranean over the last 50 years and ancient vineyards, orchards, cork woodlands and olive groves have been cleared to make way for industrial scale fruit or olive plantations, and mixed rotational farming has been replaced

by intensive monocultures. Modern farming practices also put an inordinate amount of pressure on the surrounding environment through their high demand for pesticides, fertilizers, and water irrigation. More than 26 million ha of farmland are now under irrigation in the Mediterranean basin and in some areas up to 80% of the available water is used for irrigation, which is leading to a severe overexploitation of both ground and surface waters (Sundseth 2009).

Water scarcity, the concentration of economic activities in coastal areas, and its dependence on climate-sensitive agriculture make the Mediterranean region particularly susceptible to the risk of climate change; its effects are expected to worsen the ongoing impacts of water stress and extreme climate events such as floods and droughts (European Environment Agency 2014).

Forests have always played, and still play, an important role in the daily life of people in the Mediterranean. Although Mediterranean forests provide low direct economic returns on wood products in comparison to the Northern European forests, they play a crucial role in maintaining key ecosystem components for securing human welfare and life in the region. In the Mediterranean region forests represent a substantial part of the landscape and are characterized by a high turnover of tree species related to the major environmental gradients (humidity, elevation etc.). Previously, exploitation of the natural landscape was long, slow, and relatively sustainable but that balance between nature and humankind has been lost in the last decades (Grove and Rackham 2003, Blue Plan 2008). Changes in traditional land use towards agriculture intensification, commercial forestry, and urban and infrastructure development are just some of the many human activities that are leading an ever-increasing number of Mediterranean species to be facing a high risk of extinction (Cuttelod *et al*. 2008).

1.2 Natural history of saproxylic beetles

The saproxylic habit includes representatives from all major insect orders (especially beetles and flies), and accounts for a large proportion of the insect fauna in forest ecosystems. Saproxylic beetles comprise a group of insect species dependent upon dead wood, or wood-decaying fungi, for some portion of their life cycle, and also include their predators and parasitoids (Speight 1989). They are one of the main components of forest fauna due to their high diversity and because they are involved in important ecosystem services, such as breaking down deadwood and recycling nutrients (Buse *et al*. 2009, Stokland and Sittonen 2012). Furthermore, they interact with other groups of living organisms that are very important for the well being of ecosystems and economy, such as mites, nematodes, bacteria, and fungi. Many saproxylic beetles are also involved in pollination and contribute to insect biomass in forests available for higher trophic levels such as breeding birds, bats and other insectivore vertebrates.

In forest ecosystems, dead wood and other characteristic old-growth structures play a key role in biodiversity. Dead and decaying wood offers a broad range of potential microhabitats and the different saproxylic insects segregate spatially according to tree species, kind of tissue and position in the tree, and temporally in relation to the degradative succession during wood decay, constituting complex assemblages formed by many species that show different trophic habits depending on different microhabitats and that interact among themselves and with the substrate in different ways (Quinto *et al*. 2012). Saproxylic beetles form therefore highly specialized communities in terms of trophic level and habitat requirements (Köhler 2000, Schmidl and Bussler 2004).

In that way, saproxylic insect richness depends on quantity and quality of the dead wood available in the forest, and on forest size, forest history and management. Key factors for richness of saproxylic beetles relate to the diversity of dead wood structures that is strongly linked to dead wood amount (Seibold *et al*. 2016). However, the relative impact of dead wood amount for the beetle community seems to be lower under high temperatures found in Mediterranean compared to Central European forests (Müller *et al*. 2015). Furthermore, canopy openness promotes saproxylic beetle richness leading to communities that differ between open sunny and shaded conditions.

The intensification of forestry and agriculture and the abandonment of traditional silvicultural practices have resulted in a decline in the number of old, open-grown trees and in general of large-diameter wood in both forested and agricultural landscapes (Speight 1989), and many saproxylic insects have consequently become rare or threatened with extinction due to their specific requirements for large insolated diameter wood (Nieto and Alexander 2010, Seibold *et al*. 2016).

Not much is known about saproxylic insects in the Mediterranean (Carpaneto *et al*. 2017, Bartolozzi *et al*. 2017) and any research on this group enhances our knowledge of the functioning of ecosystems in wooded landscapes and open possibilities to use them in identifying key sites for nature conservation or for monitoring the sustainability of forest management (Grove 2002).

1.3. Overview of the Mediterranean saproxylic beetles

The species assessed in this study belong to 18 selected taxonomic groups covering all trophic levels in the saproxylic guild: Bostrichidae (**powder-post beetles or twig borers**), Bothrideridae (**cocoon-forming beetles**), Buprestidae (**jewel beetles**), Cetoniinae (**flower chafers**), Cerambycidae (**longhorn beetles**), Cucujidae (**flat bark beetles**), Dynastinae (**rhinoceros beetles**), Elateridae (**click beetles**), Cleridae (**checkered beetles**), Eucnemidae (**false click beetles**), Lucanidae (**stag beetles**), Mycetophagidae (**hairy fungus beetles**), Tetratomidae (**polypore fungus beetles**), Erotylidae (**pleasing fungus beetles**), Rhysodidae (**wrinkled bark beetles**), Scarabaeidae Euchirini (**long armed beetles**) Trogossitidae (**bark-gnawing beetles**) and Zopheridae (**ironclad beetles**), (see Table 1). About 508 species of obligate saproxylic beetles of these families were identified as native to the Mediterraenan region

Almost two thirds (194 species, 61%) of the 320 Mediterranean saproxylic beetles assessed are endemic, that is, they occur only in this region. For the taxonomic groups with all the saproxylic species present in the region assessed, those with the highest rates of endemism are Tetratomidae (two of three), Euchirini (one of two) and Dynastinae (one of two). However, most endemic species were found in longhorn beetles (Cerambycidae) (Table 1).

Based on the dependency on dead wood for their survival in any development phase, saproxylic beetles may be facultative saproxylics (i.e. feeding generalists associated with dead wood during one or more parts of its life cycle) or obligate saproxylics (i.e. depend upon wood or other saproxylic organisms to fulfill at least one part of its life cycle; definitions according to Dahlberg and Stokland (2004).

The assessments were limited to taxa of obligate saproxylics whose global distribution is primarily within the borders of the Mediterranean and therefore native species with more than 25% of their range outside the region were excluded. Also, two species have been classified as Not Applicable and therefore excluded from this assessment because they were introduced to the region after 1500 AD.

A male of the stag beetle *Lucanus tetraodon* from Aspromonte National Park, Calabria, Italy. This species lives in broad-leaved forests of south of France, Italy, Greece, Albania and Spain. Photo ©Francesco Manti and Elvira Castiglione.

Figure 1. **The Mediterranean region as defined for this project.**

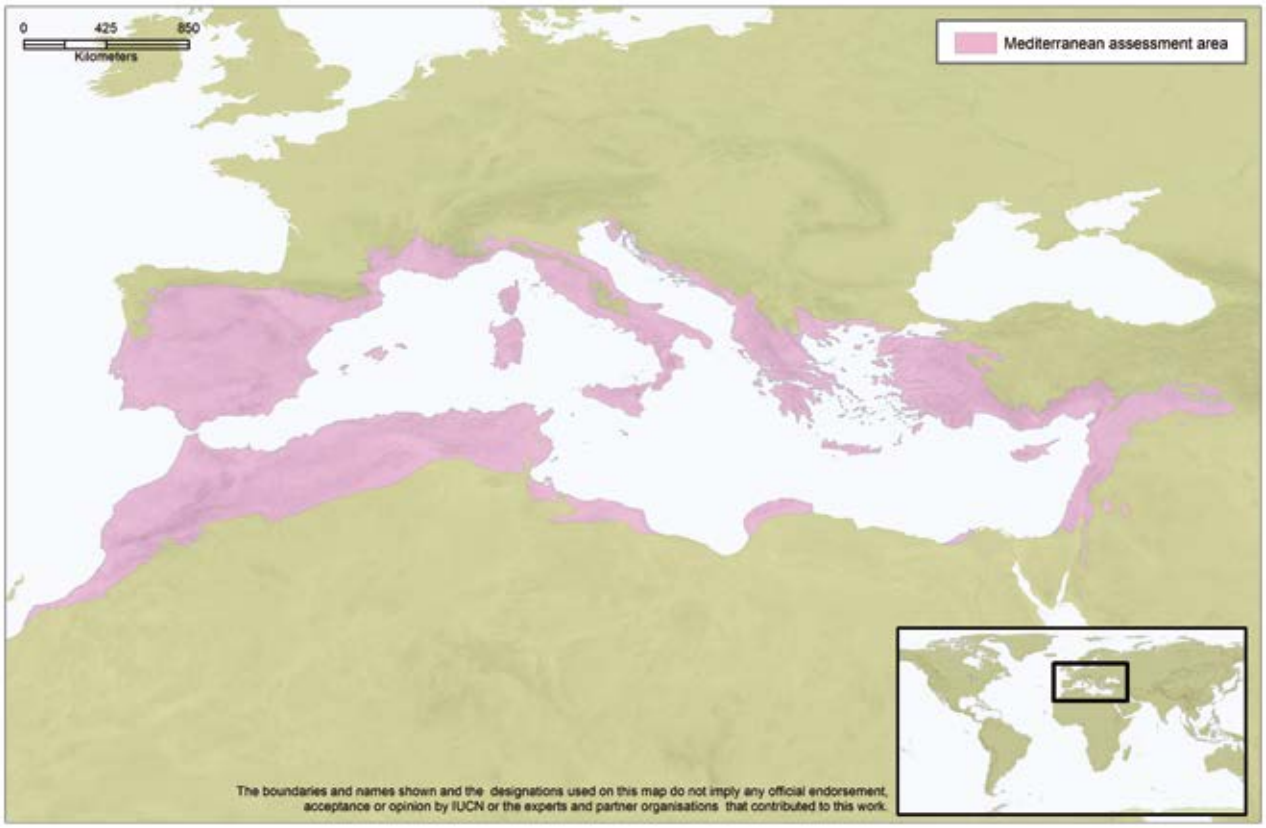

Table 1. Diversity and endemism in taxonomic groups of saproxylic Coleoptera in the Mediterranean region[1].

Family	Subfamily	Number of species in Mediterranean countries*	Number of species assessed	Number of endemic species assessed
Bostrichidae			11	3
Bothrideridae			4	1
Buprestidae*			1	0
Cerambycidae			105	57
Cleridae		108	23	17
Cucujidae			1	1
Elateridae			78	55
Erotylidae			16	12
Eucnemidae			4	2
Lucanidae		18	13	5
Mycetophagidae			12	12
Rhysodidae			1	1
Scarabaeidae	Cetoniinae		10	5
Scarabaeidae	Dynastinae		2	1
Scarabaeidae	Melolonthinae/ Euchirini	1	1	0
Tetratomidae*			3	2
Trogossitidae		12	6	3
Zopheridae			29	17
			320	**194**

[1] This table includes species that are native or were naturalised before 1500 AD. Taxa of marginal occurrence or introduced in the Mediterranean region are also included. * An asterisk indicates that the family (or subfamily) has been comprehensively assessed.

Mating couple of *Chlorophorus glaucus* on a trunk of Algerian oak *Quercus canariensis* in Parque Natural Los Alcornocales, Spain. Listed as Least Concern. ©Antonio Verdugo

1.4. Objectives of the regional assessment

Besides evaluating the extinction risk of saproxylic beetles native to the Mediterranean region using IUCN´s Red List Categories and Criteria, the main objectives of this regional assessment were:

- to contribute to regional conservation planning by providing a baseline dataset describing the conservation status of Mediterranean saproxylic beetles;
- to identify geographic areas in need of conservation measures to prevent extinctions and ensure that Mediterranean saproxylic beetles reach and maintain a favourable conservation status;
- to develop a network of regional experts which can enable species assessments to be continually updated as new information is discovered and to provide expert opinion on policy and management recommendations.

The main outputs of this assessment are:

- a species list of obligate Mediterranean saproxylic beetles from selected taxonomic groups;
- an IUCN Red List categorization of those species endemic and almost endemic to the Mediterranean;
- a summary of the main threats affecting Mediterranean saproxylic beetles;
- a set of recommendations for the future conservation of Mediterranean saproxylic beetles and their habitats.

The data presented in this report provides a snapshot of the conservation status of Mediterranean saproxylic beetles based on the knowledge available at the time of the assessment. The database will continue to be updated and made freely available. IUCN will facilitate wide dissemination of this document to concerned decision makers, scientists, and non-governmental organizations to mobilize Mediterranean native saproxylic beetle conservation action at the local, national, and regional levels.

Chapter 2.
Assessment methodology

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The click beetle *Ampedus sinuatus* inhabits forest-steppe formations and open mixed south-facing forests. In the Mediterranean, it is listed as Near Threatened because its habitat is being lost due forest clear-cutting activities followed by to stump removal Photo. ©Nikola Rahme.

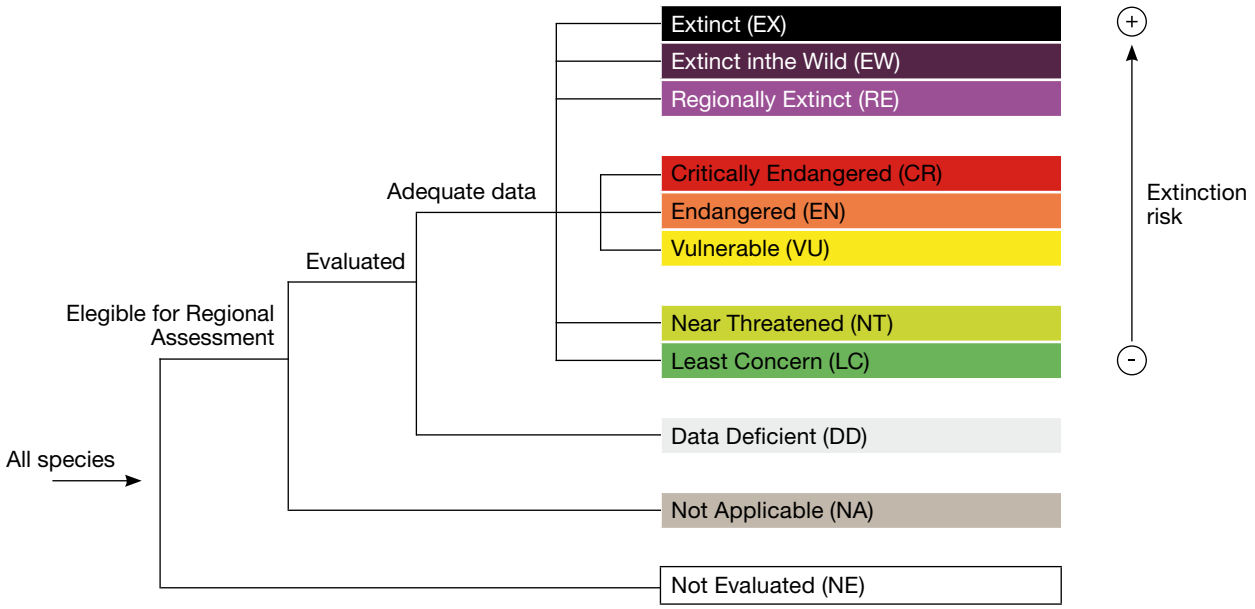
2.1 The IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species™ (IUCN Red List) is widely recognized as the most comprehensive, scientifically based source of information on the global conservation status of plant and animal species, integrating data on ecology and life history, distribution, habitat, threats, current population trends and conservation measures. The relative threat of extinction of each individual taxon is determined by applying IUCN Red List Categories and Criteria (Figure 2). Species assessed under the categories Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) are considered as Threatened and face the highest risk of extinction. Taxa that are either close to meeting the threatened thresholds (Figure 3), or would be threatened were it not for ongoing conservation programmes, are classified as Near Threatened (NT). Taxa evaluated as having a relatively low risk of extinction are classified as Least Concern (LC). Also highlighted within the IUCN Red List are taxa that cannot be evaluated due to insufficient knowledge, and which have therefore been assessed as Data Deficient (DD). This category does not necessarily mean that the species is not threatened, only that its risk of extinction cannot be assessed from current data (IUCN 2017). Species assessed as DD are highlighted as priorities for additional research and are acknowledged as being potentially threatened. The species that has not yet been assessed under the IUCN Red List Categories and Criteria are classsifed as Not Evaluated (NE).

Additionally, when conducting regional or national assessments, the IUCN Red List Regional Guidelines (IUCN 2012b) are applied and two additional categories are used: Regionally Extinct (RE) and Not Applicable (NA) (Figure 2).

IUCN Red List assessments can be used as a tool for measuring and monitoring changes in the status of both biodiversity and our knowledge of the individual taxa. They are an essential basis for providing targets for management priorities, and for monitoring the long-term success of management and conservation initiatives.

Figure 2. IUCN Red List Categories at the regional level (IUCN 2012b). For an explanation of the full range of categories and the criteria that must be met for a species to qualify under each category, please refer to The IUCN Red List Categories and Criteria: Version 3.1 and Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0, which can be downloaded from http://www.iucnredlist.org/technical-documents/red-list-documents.



The following criteria for the inclusion of a species in the Mediterranean assessment were applied in the completion of this Red List assessment:
1. Any species having less than 5% of its range within the project area should not be assessed through this project.
2. Species present in the project area prior to the year 1500 AD were treated as being “naturalised” and subject to a Red List assessment. Those species arriving in the region post year 1500 AD were not assessed.

RED LIST

DATA DEFICIENT

DD

The longhorn beetle *Prionus besikanus* is found in the north eastern part of the region, and it is listed as Data Deficient in the Mediterranean © Nikola Rahme.

Figure 3. Summary of the five criteria (A–E) used to determine the category of threat for a species. Use of this summary sheet requires full understanding of the IUCN Red List Categories and Criteria and Guidelines for Using the IUCN Red List Categories and Criteria. Please refer to both documents for explanations of terms and concepts used here.

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased.
A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.
A3 Population reduction projected, inferred or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*].
A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation [*except A3*]
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality
(d) actual or potential levels of exploitation
(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)

	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented **OR** Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** area, extent and/or quality of habitat; **(iv)** number of locations or subpopulations; **(v)** number of mature individuals			
c) Extreme fluctuations in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** number of locations or subpopulations; **(iv)** number of mature individuals			

C. Small population size and decline

		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):		25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions:				
(a)	**(i)** Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b)	Extreme fluctuations in the number of mature individuals			

D. Very small or restricted population

	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	**D1.** < 1,000
D2. *Only applies to the VU category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	-	-	**D2.** typically: AOO < 20 km² or number of locations ≤ 5

E. Quantitative Analysis

	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

2.2 The IUCN Red List Mediterranean initiative

The extinction risk of a species can be assessed at a global, regional or national level. A taxon can have a different category in the Global Red List and a Regional Red List. For instance, a species that is common worldwide and listed as Least Concern (LC) in the Global Red List could face a high level of threat and meet the criteria of a threatened category, for example Endangered (EN), in a particular region. To avoid an over- or underestimation- of the regional extinction risk of a species, the guidelines for the application of IUCN Red List Criteria at regional level (IUCN 2012b) should be applied. An endemic species should have the same category at the regional and global level, as it is not present in any other part of the world.

Therefore, the present regional assessment for the Mediterranean region not only evaluates the conservation status of this taxonomic group at the regional level, but also contributes to their more comprehensive assessment at the global level as it includes regional endemics.

2.3 Geographical scope

This assessment covers the Mediterranean region as outlined by the Mediterranean Basin Biodiversity Hotspot (Mittermeier *et al*. 2004) with exception of the Macaronesian (Atlantic) islands (Figure 1). The region covers total or partial territories of the countries of Albania, Algeria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Egypt, France, Greece, United Kindgom (Gibraltar), Israel, Italy, Jordan, Lebanon, Libyan Arab Jamahiriya, FYR Macedonia, Malta, Monaco, Montenegro, Morocco, Palestine, Portugal, San Marino, Serbia, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey and Western Sahara.

2.4 Taxonomical scope

This regional assessment evaluates a total of 320 native Mediterranean species. A checklist of all of these regionally assessed species is provided in Appendix 1. The species having less than 75% of distribution range within the borders of the region are also included in Appendix 1 under category Not Evaluated (NE). Taxonomy mainly follows Löbl and Smetana (2007-2013) and Löbl and Löbl (2016).

The taxonomic placement of species and their higher taxonomy often changes as a result of new information from ongoing studies of the species, especially with the introduction of molecular techniques. In addition, the taxonomy of many species is complicated, and different researchers may have different opinions on taxonomic boundaries of those species; i.e., whether some individuals should be recognized as the same or different species, or should be placed in different genera. Therefore, it can sometimes be difficult to find universally agreed upon taxonomic hypotheses and nomenclatural hierarchy. In the case of this project, the taxonomic nomenclature follows the protocols of the IUCN Red List, which, where possible, employs existing published taxonomic authorities as the source of information. For more information on the taxonomic standards of the IUCN Red List, visit: http://www.iucnredlist.org/technical-documents/information-sources-and-quality.

2.5 Overlap with other Red List assessment projects

Some species that are present within the Mediterranean region, and therefore of interest to this project, have already been assessed through other ongoing assessment in adjacent regions of Europe (Nieto and Alexander 2010, Calix *et al*. 2018). In these cases, information that was compiled for the species in the Mediterranean was added to the existing assessment information from elsewhere and, if necessary, any adjustment of the global threat status of the species was made. As noted above, the information that was specific to the Mediterranean was used to make an assessment of the regional risk of extinction within the region.

2.6 Data collection, assessment and review

The biodiversity assessments required sourcing and collating the best information on all known species occurring in the Mediterranean region, including data on habitat and ecology, distribution, threats and conservation measures. Experts from across the region were identified through IUCN´s Species Survival Commission and other national and regional networks of scientists. Museum and personal collections were checked by the experts for gathering data on the geographic distribution, altitudinal range and phenology of the species. All the relevant and available information on each species was input into the IUCN species database (Species Information Service, SIS).

A group of key Mediterranean saproxylic beetle experts was invited to attend a four-day regional review workshop in Alicante, Spain, in December 2015. During this meeting, the experts were asked to review the species summary reports using a peer-review methodology and their comments, together with any additional up-to-date information, were included in the assessments. Focused working groups were organised to efficiently review identified geographical and taxonomical sets of species. New information was added to the species summaries, maps were drafted, and corrections to existing data were made.

A male of the checkered beetle *Tillus ibericus* under bark of the evergreen oak *Quercus ilex* in Sierra de Grazalema Natural Park, southern Spain. This species, endemic to the Mediterranean region, is listed as Least Concern © Antonio Verdugo.

Preliminary Red List Assessments for each species were carried out. Facilitation staff from the IUCN Centre for Mediterranean Cooperation and the IUCN European Regional Office reviewed the assessments to ensure they complied with the guidelines for application of the IUCN Red List Categories and Criteria and included the most up-to-date comprehensive information. Following the review workshop the data were edited and outstanding questions were resolved through follow-up communications with the workshop participants. The post-workshop draft assessments were also made available to allow the participating experts to make any final edits and/or corrections. Experts from Mediterranean countries as well as from the IUCN Invertebrate Specialist Group were asked to review the species summary reports using a peer-review methodology. After data gathering, collation, and corrections, IUCN experts from the Red List Unit integrated the various data sets that were used to draft this regional report.

Supported by relevant data sources and by scientific literature, these final regional assessments and this report are therefore the outcomes of information exchange and agreement between the numerous Mediterranean specialists involved and their networks of informed colleagues.

2.7 Species mapping and regional analysis

Complementarily, spatial data were also gathered for the production of distribution maps using ArcView GIS software. When point localities were not available for some taxa, maps were drawn based on expert knowledge and literature.

Mediterranean distributions were mapped based on a tree cover layer from Global Forest Watch (Hansen *et al*. 2013), using ArcMap GIS software. The initial raster was encoded with values 0-100, where 0 represents no tree cover for the year 2000, and values 1-100 represent the percent tree cover canopy density for each pixel in the year 2000. The layer was adapted for this taxonomic group of beetles with selected values from 20 to 100, which means that pixels had 20-100% canopy cover in 2000. It is recognised that species ranges may not always extend throughout a forest area, but presence within the forest is either 'known' or 'inferred' (either Extant: presence is known from field survey or recent literature, or Probably Extant: presence inferred based on expert opinion). Where possible, point localities (the latitude and longitude where the species has been recorded) were used to identify which tree cover areas are known to contain the species.

For the spatial analyses, data were analyzed using a geodesic discrete global grid system, defined on an icosahedron and projected to the sphere using the inverse Icosahedral Snyder Equal Area (ISEA). This corresponds to a hexagonal grid composed of individual units (cells) that retain their shape and area (~864 km^2 per cell in Projection: Lambert Azimuthal Equal Area). These are more suitable for a range of ecological applications than the most commonly used rectangular grids. The range of each species was converted to the hexagonal grid for analysis purposes. Coastal cells were clipped to the coastline. Patterns of species richness were mapped by counting the number of species in each cell (or cell section for species with a coastal distribution). Patterns of threatened species richness were mapped by counting the number of threatened species (categories CR, EN, VU at the Mediterranean regional level) in each cell or cell section. Patterns of endemic species richness were mapped by counting the number of species in each cell (or cell section for coastal species) that were flagged as being endemic to the Mediterranean region as defined in this project. Patterns of Data Deficient species richness were mapped by counting the number of species in each cell (or cell section for coastal species) that were flagged as being listed as Data Deficient at the Mediterranean level.

Expert participants at the Mediterranean Saproxylic Beetles Red List workshop, December 2015, Alicante, Spain. (left to right) Front row: Benoit Dodelin, Diana Pérez, Lucía González, Ana Nieto, Salwa El-Antry, Violeta Barrios, Paolo Audisio; middle row: Gabriel Souba, Hervé Brustel, Antonio Verdugo, Margherita Norbiato, Catherine Numa, Luca Bartolozzi; back row: Pablo Ramilo, Eduardo Galante, José Carlos Otero, Marcos Méndez, Estefanía Micó, Jörn Buse, José Luiz Zapata.© IUCN Med.

Chapter 3. Assessment results

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3.1. Conservation status of Mediterranean saproxylic beetles

This chapter presents an overview of the current status and distribution of saproxylic beetles in the Mediterranean, including the results and analysis of the assessment, and valuable base-line knowledge to be taken into consideration in environmental and development planning throughout the region.

Up to 507 saproxylic beetle species are known to occur in the Mediterranean region as defined in this project. Out of these, 320 species have a distribution predominately Mediterranean (more than 75% of their range) and therefore were included in the present analysis. About 187 species with less than 75% of their distribution range within the region were excluded. Also, two species (Not Applicable, NA) were identified as non-native to the region and also excluded: the Black borer *Apate monachus* and the Monkeypod roundheaded borer *Xystrocera globosa*.

The taxon of Scarabaeidae Dynastinae *Calicnemis sardiniensis*, endemic to Sardinia, and the Scarabaidae Euchirini *Propomacrus cypriacus* endemic to Cyprus, which were previously considered as valid species, are now subspecies of the West-Mediterranean *Calicnemis obesa* (Verdugo and Drumont 2015) and *Propomacrus bimucronatus* (Pallas, 1781) respectively. Because of this change, only the latter were included in the analysis, which only deals with taxa at the species rank.

The *Osmoderma* species complex is here treated as four separate species: *O. barnabita*, *O. eremita*, *O. cristinae* and *O. lassallei*. Distribution limits of these different forms remain poorly resolved, but for the purpose of this assessment we followed the approximate distribution limits outlined in Audisio *et al.* (2007, 2009). There is ongoing debate as to whether or not *Osmoderma italicum* constitutes a valid species, but for the objective of this assessment we are following the most up-to-date taxonomy that considers this taxon a synonym of *O. eremita*.

The complete list of saproxylic beetle taxa considered for this project and their Mediterranean IUCN Red List status is provided in Appendix 1. The number and proportion of species in the different IUCN Red List Categories are presented in Table 2 and Figure 4.

To summarize, 61 species of the regionally assessed taxa were found to be threatened with extinction in the Mediterranean. They include 1 species (0.3%) categorised as Critically Endangered (CR), 38 species (12%) listed as Endangered (EN) and 22 species (7%) classified in the category Vulnerable (VU) (Table 2 and Figure 4). An additional 29 species (9% of the total) are listed as Near Threatened, 131 species (41%) as Data Deficient, and 99 species (31%) as Least Concern.

Table 2. **Summary of the Red List status of saproxylic beetles in the Mediterranean region.**

	IUCN Red List Category	Number of native species	Number of endemic species
Threatened categories	Extinct (EX)	0	0
	Regionally Extinct (RE)	0	0
	Critically Endangered (CR)	1	1
	Endangered (EN)	38	29
	Vulnerable (VU)	22	19
	Near Threatened (NT)	29	18
	Least Concern (LC)	99	26
	Data Deficient (DD)	131	101
	Not Applicable (NA)	2	0
	Total number of species analyzed	507	194
	Total number of species assessed	320	194

Figure 4. **Red List status of saproxylic beetles in the Mediterranean region.**

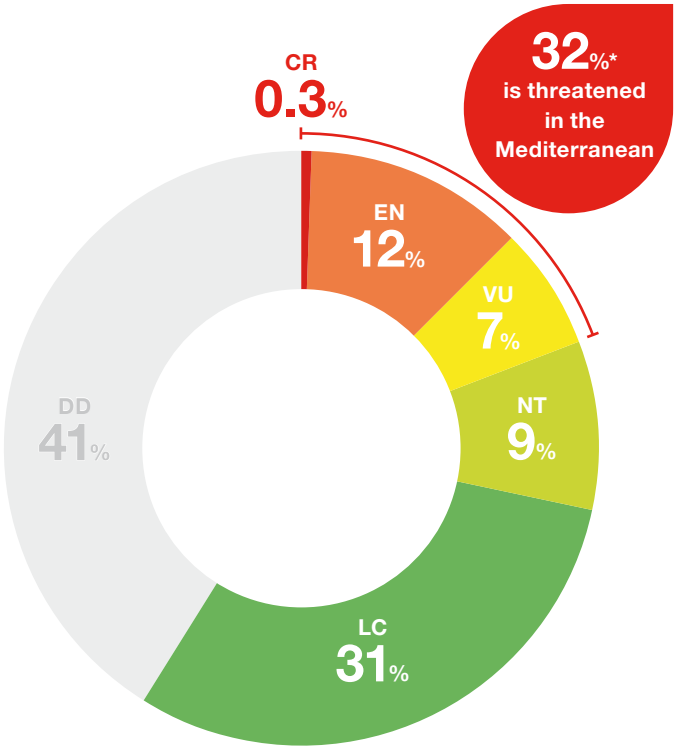
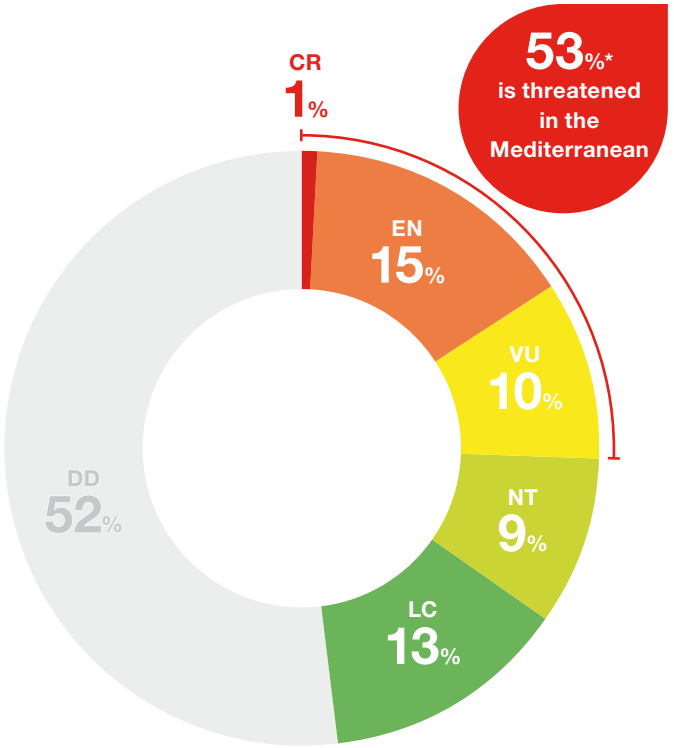


Figure 5. **Red List status of Mediterranean endemic saproxylic beetles.**



*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).

3.2 Threatened and Endemic species

At least 61 of the taxa assessed are seriously threatened with extinction (19% of the total assessed), which means that they are listed either in the category Critically Endangered, Endangered, or Vulnerable. A very high proportion of these (79%; 49 species) are endemic to the region, which puts them in the spotlight for conservation concern (Tables 2 and 5, Figure 5).

Also, due to the high number of Data Deficient species, the proportion of threatened species may potentially range between a possible lower value of 19.1%, if all DD species are considered not threatened, and a higher value of 60%, if all DD species are threatened (Table 3). However, the midpoint, which in this case is 32.3%, is considered the best estimate of the proportion of threatened species (IUCN 2011).

Compared to other terrestrial groups comprehensively assessed at the Mediterranean level according to IUCN regional Red List guidelines, saproxylic beetles have the highest proportion of threatened terrestrial species with amphibians at 30%, followed by mammals at 18%, reptiles at 23%, butterflies at 4% and birds at 6% (Numa *et al.* 2016, Critical Ecosystem Partnership 2017).

Table 3. Proportion of threatened species in the Mediterranean region.

Calculation	% threatened
Lower bound (CR + EN + VU) / (assessed – EX)	19.1
Mid-point (CR + EN + VU) / (assessed – EX – DD)	32.3
Higher bound (CR + EN + VU + DD) / (assessed – EX)	60.0

More than three fifths (61%; 194 taxa) of the saproxylic beetles assessed are endemic to the Mediterranean region, i.e., they do not exist anywhere else in the world, and therefore their regional Red List status also corresponds to their risk of extinction at the global level. More than one quarter of these endemics are threatened with extinction including the only species listed as Critically Endangered, *Trichoferus bergeri*, endemic to Crete. Habitat lost due to extraction, clearing and destruction of mature hollow trees, which have a key role in the life cycle of these two beetles, is the main specific threat to their populations.

Twenty nine of the 38 taxa categorized as Endangered are endemic.

Intensive forestry, overgrazing, and forest fires are major threats to the Endangered longhorn beetles endemic to northern Africa, *Vesperella maroccana* and *Neomarius gandolphii*, both being very habitat specific, having restricted distributions, and facing severely fragmented populations.

Other relevant Endangered species endemic to the Mediterranean are two beetles of the family Erotylidae: *Triplax castanea*, which is suffering a continuing decline of its habitat quality, especially as coastal areas in North Africa are being urbanised and oak forests replaced by plantations, and *Triplax emgei*, which is restricted to Greek high mountains and lives in fungal fruiting bodies on the dead wood of *Abies cephalonica* a habitat subject to ongoing decline due to forest fires and over-grazing.

The larva of the flat bark beetle, *Cucujus tulliae*, endemic to Italy, and listed as Endangered, depends on the availability of high amounts of dead wood present in the mature mountain forests of high conservation value of Calabria region. Changes in tree composition, loss of primary habitat and its basic requirements such as dead wood supply and sun-exposure, are major threats to this species.

Three endemic ironclad beetles *Diodesma besucheti*, *Pycnomerus italicus* and *Tarphius besucheti*, are also listed as Endangered. Grazing in forests producing compacting of the soil through cattle trampling forest fires and inadequate forest management, are the main threat to these species at present.

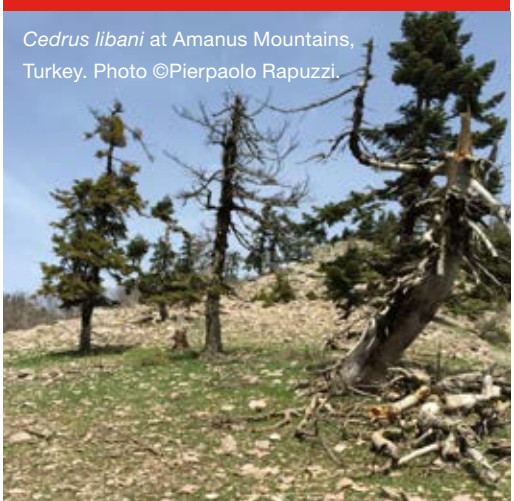
Inadequate forest management and loss of habitat are a threat for *Dorcus alexisi*, a rare stag beetle species endemic to the island of Cyprus, which inhabits decaying wood and tree stumps, including those of cherry trees (Muret and Drumont 1999).

THE CLOSE RELATIONSHIP BETWEEN ENDEMIC *GLAPHYRA SPP.* AND CEDAR TREES IN THE EASTERN MEDITERRANEAN

Glaphyra is a genus of longhorn beetles in the family Cerambycidae. In the eastern Mediterranean, cedar forests provide the specific habitat required by *Glaphyra bassettii* and *Glaphyra tenuitarsis*, two singular beetles that are endemic to Cyprus and Turkey respectively. The only known host for the larvae of *Glaphyra bassettii* is Cyprus cedar *Cedrus brevifolia*, while the larva of *Glaphyra tenuitarsis* solely develops on Lebanon cedar trees, *Cedrus libani*.

Habitat loss due to overgrazing, particularly by goats, well known to eat **cedar seedlings**, and wood-cutting, are the major threats to the species. Also, these species of cedars are only present in high elevations of the eastern Mediterranean region, where several mature trees grow in poor sites and are susceptible to die-back diseases caused by several factors including the changing climatic conditions, particularly by an increased frequency of droughts (Christou *et al*. 2001).

Given their dependence on cedars, conservation measures for *Glaphyra* species must be focused on host tree preservation. Strong protection of remaining cedar forests is necessary, and reduction of the grazing intensity in high mountainous areas is also needed to promote natural tree regeneration and health.



Cedrus libani at Amanus Mountains, Turkey. Photo ©Pierpaolo Rapuzzi.

Nineteen of the twenty-two species in the Red List category Vulnerable are endemic.

In northern Africa, as dead wood is a scarce resource some species of saproxylic beetles, like the large checkered beetle *Thanasimodes dorsalis* are threatened by dead wood harvesting, logging and forest fires. The same factors also affect the zopherid *Tarphius oulmesensis*. Both species are endemic to the Maghreb and have been assessed as Vulnerable.

In southwestern Europe the false click beetle *Melasis fermini*, endemic to Spain, is threatened by forest management activities, mainly dead wood removal, which are seriously contributing to the decline of its specific habitat, broad-leaved woodlands with *Alnus glutinosa*.

Coastal forests of *Quercus* spp. are the specific habitat of the stag beetle *Lucanus busignyi*, a species endemic to Turkey, which is threatened by future tourism infrastructure development and urbanisation. Another member of the family Lucanidae also endemic to the Mediterranean is *Dorcus musimon*. The fragmented distribution of this beetle in Algeria, Tunisia, and Sardinia, makes it particularly susceptible to habitat loss due to exploitation from forestry and fires (Bartolozzi *et al*. 2016).

Three species of the genus *Esarcus* (familiy Mycetophagidae) endemic to the Mediterranean in Spain (*Esarcus franzi*), Italy (*Esarcus fiorii*), and the Mediterranean Alps (*Esarcus baudii*) are listed as Vulnerable. These flightless taxa live on myceliums of lignicolous fungi and are flightless, and therefore have a weak dispersal ability that makes their subpopulations prone to isolation. Moreover, they are subject to local disappearance in the case of severe wildfires, a main threat in their distribution range.

The wrinkled bark beetle *Clinidium canaliculatum* is the only wrinkled bark beetle (family Rhysodidae) endemic to the Mediterranean region and is threatened by forest management activities such as old tree cutting dead wood clearing, and forest fires. This rare species known solely to Greece and Italy inhabits very mature forests in large pieces of wood that are wet, not exposed to the sun, and have been subject to long periods of decay.

Human activities associated with the conflict along Syrian-Turkish border, the only area where the iron clad beetle *Nosodomodes syriacus* has been recorded, including forest fires, human disturbance, and overgrazing, are the main threats supporting its categorization as Vulnerable.

Tetratoma tedaldi is a polypore fungus beetle endemic to Italy and associated with saproxylic fungi, chiefly in mature deciduous forests. It isthreatened by habitat loss due to unsustainable exploitation of forests where management involves long-term changes towards canopy closure and loss of old trees.

The Mediterranean saproxylic beetles assessed in this study belong to a number of different families (Table 4). Some of the fully assessed families are of particular concern because the high proportion of species listed as threatened within the family: Buprestidae (one species: *Buprestis splendens*), Euchirini (one species: *Propomacrus bimucronatus*), and Dynastinae (two species: *Calicnemis latreillei* and *Calicnemis obesa*).

MEDITERRANEAN RHINOCEROS BEETLES: A QUEST TO SURVIVE ON DRIFTWOOD IN A CHANGING ENVIRONMENT

Rhinoceros beetles (Scarabaeidae Dynastinae) include some of the largest of beetles of the world. In the Mediterranean region, two small saproxylic species of this subfamily have been assessed, *Calicnemis obesa* and the endemic *Calicnemis latreillei*; both listed as Endangered.

They develop in a very particular habitat: wood present in coastal dunes and sand beaches. As a result, they are particularly at risk due to the intense exploitation of coastal environments that is taking place in the region, as well as the extensive and rapid urbanization of the littoral zone in large tourism development projects. This can lead to an irreversible destruction of the habitat of many species of animals and plants.

Conservation measures needed to protect these species include: recommending the selective manual cleaning of sand beaches and dunes from non-organic debris, emphasizing the importance of the preservation of dead wood in these habitats, implementing protected areas along sand coasts and rejecting unsustainable development projects based on heavy transformation of the habitats.

Table 4. Red List status at Mediterranean level of assessed saproxylic beetles by taxonomic family.

Family	Total*	CR	EN	VU	NT	LC	DD	% Threatened
Bostrichidae	11	0	0	0	0	9	2	0
Bothrideridae	4	0	2	0	0	1	1	50
Buprestidae*	1	0	0	1	0	0	0	100
Cerambycidae	105	1	14	4	11	49	26	18
Cleridae	23	0	1	2	1	5	14	13
Cucujidae	1	0	1	0	0	0	0	100
Elateridae	78	0	5	1	7	14	51	8
Erotylidae	16	0	2	0	2	2	10	13
Eucnemidae	4	0	0	1	1	1	1	25
Lucanidae	13	0	2	2	1	4	4	31
Mycetophagidae	12	0	0	3	2	1	6	25
Rhysodidae	1	0	0	1	0	0	0	100
Scarabaeidae Cetoniinae	10	0	5	3	0	2	0	80
Scarabaeidae Dinastinae*	2	0	2	0	0	0	0	100
Scarabaeidae Euchirini*	1	0	0	1	0	0	0	100
Tetratomidae*	3	0	0	1	1	0	1	33
Trogositidae	6	0	0	0	1	1	4	0
Zopheridae	29	0	4	2	2	10	11	21
	320	**1**	**38**	**22**	**29**	**99**	**131**	**19**

* An asterisk indicates that all the species of the taxonomic group present in the Mediterranean region have been assessed. Note that the % of threatened species is also displayed for taxonomic groups that are not fully assessed, even if in such cases the percentages could result in misinterpretation.

The Endangered flower chafer *Osmoderma cristinae* is endemic to the Italian island of Sicily. Degradation or loss of habitat due to exploitation from forestry and forest fires, as well as uncontrolled collection of specimens are the main threats to its population. Photo © Nicolas Gouix and Hervé Brustel.

RED LIST
ENDANGERED
EN

MEDITERRANEAN FLOWER CHAFERS: HIGH LEVELS OF THREAT AND ENDEMISM

The Scarab beetles of the subfamily Cetoniinae are commonly known as flower chafers because the adult visits flowers for pollen and nectar or to browse on the petals. The larvae of several Mediterranean species are known to develop in accumulations of wood mold within living hollow trees, usually in trunks and main boughs with large cavities containing adequate volumes of wood mold derived from natural fungal decay of the dead heartwood; they also occurs in composts and the rhizosphere.

Out of the ten species known to live in the region, eight have been listed as threatened, including five which are Endangered and three Vulnerable taxa. Together they represent 2% of the threatened and endemic saproxylic beetle fauna of the region.

The main threats to these species are loss, degradation and fragmentation of habitats (old forests), and increasing isolation of beetle populations due to uncontrolled and inappropriate management of remaining old forests, forest fires, and the removal of deadwood and old trees, which reduce the availability of suitable habitat. In particular, activities that destroy veteran trees, the main source of habitat to which this species is restricted, is highly detrimental to the species. Unregulated collection of specimens is also a major cause of concern for most of the taxa in this family. The use of insecticides and land use modification due to urbanization and infrastructure development are also relevant threats for some of these species.

A well-known representative is the Violet flower chafer *Protaetia mirifica*, a remarkable bio-indicator species of old thermophilous oak groves on the northern and eastern coast of the Mediterranean basin. During the last glaciation, this species was able to survive in a number of areas that have been traditionally regarded as refugia in the Mediterranean region: the southern Iberian Peninsula, southern Italy, the Balkans, Turkey, and the Middle East. This species is listed as Vulnerable due to removal of old trees and dead wood, forest fires, land use change, and to a small extent also to uncontrolled trade of specimens for collectionist due to its eye-catching look.

Non endemic and threatened species

A set of saproxylic beetles not endemic to the region, i.e. with one or more of their subpopulations occuring outside the Mediterranean region, have been identified as threatened at the regional level: *Tetrigus cyprius*, *Ectamenogonus montandoni*, *Propomacrus bimucronatus*, *Xylolaemus fasciculosus*, and *Dorcus peyronis*. The limited dispersal ability of these species makes them hard to travel long distances and therefore acts as a source for recolonization. An example of this is the click beetle *Tetrigus cyprius*, associate with old hollow trees and listed as Endangered due to the main threat of removal of coarse wood from forests and wildfires, which are becoming increasingly frequent in the region.

Even though it is more widely distributed in Europe, another click beetle *Ectamenogonus montandoni* has a scattered distribution pattern, especially in the western part of the Mediterranean. In the Mediterranean region. This species is listed as Vulnerable due to the main threat of habitat loss as it is entirely dependent upon decaying heartwood in big old trees in pasturelands.

The long armed scarab *Propomacrus bimucronatus*, inhabiting tree-hollows, is restricted and localized to residual old forests with veteran trees, a highly fragmented habitat type which is subject to continuing significant decline across the Mediterranean region due to inadequate forest management. This species is listed as Vulnerable at regional level.

Xylolaemus fasciculosus is an ironclade beetle, rare in the Mediterranean region, where it is only known from a few specimens recorded in old natural forests located very far from each other and threatened by the removal of trees, use of insecticides, the lack of new tree generation, and the increasing frequency of forest fires. The stag beetle *Dorcus peyronis* is a very rare species that, in the Mediterranean, has been recorded in dead roots of deciduous trees (*Platanus* spp., *Quercus* spp., *Populus* spp.), it is listed as Endangered due to loss of habitat connectivity because of tree cutting, forest fires, and urban development.

Table 5. **Saproxylic beetle species listed as threatened at the Mediterranean regional level.**

Family	Species name	Category	Endemic
Cerambycidae	*Trichoferus bergeri*	CR	yes
Bothrideridae	*Bothrideres interstitialis*	EN	
Bothrideridae	*Dastarcus libanicus*	EN	
Cerambycidae	*Anaglyptus luteofasciatus*	EN	yes
Cerambycidae	*Anaglyptus praecellens*	EN	yes
Cerambycidae	*Callidium libani*	EN	yes
Cerambycidae	*Glaphyra bassettii*	EN	yes
Cerambycidae	*Glaphyra tenuitarsis*	EN	yes
Cerambycidae	*Isotomus jarmilae*	EN	yes
Cerambycidae	*Isotomus theresae*	EN	yes
Cerambycidae	*Neomarius gandolphii*	EN	yes
Cerambycidae	*Poecilium gudenzii*	EN	yes
Cerambycidae	*Poecilium kasnaki*	EN	yes
Cerambycidae	*Pseudomyrmecion ramalinum*	EN	yes
Cerambycidae	*Pseudosphegesthes bergeri*	EN	yes
Cerambycidae	*Semanotus algiricus*	EN	yes
Cerambycidae	*Vesperella maroccana*	EN	yes
Cleridae	*Opilo orocastaneus*	EN	yes
Cucujidae	*Cucujus tulliae*	EN	yes

Family	Species name	Category	Endemic
Elateridae	*Ampedus assingi*	EN	yes
Elateridae	*Ampedus rifensis*	EN	yes
Elateridae	*Ectamenogonus montandoni*	EN	
Elateridae	*Stenagostus sardiniensis*	EN	yes
Elateridae	*Tetrigus cyprius*	EN	
Erotylidae	*Triplax castanea*	EN	yes
Erotylidae	*Triplax emgei*	EN	yes
Lucanidae	*Dorcus alexisi*	EN	yes
Lucanidae	*Dorcus peyronis*	EN	
Scarabaeidae Cetoniinae	*Gnorimus baborensis*	EN	yes
Scarabaeidae Cetoniinae	*Gnorimus decempunctatus*	EN	yes
Scarabaeidae Cetoniinae	*Osmoderma brevipennis*	EN	
Scarabaeidae Cetoniinae	*Osmoderma cristinae*	EN	yes
Scarabaeidae Cetoniinae	*Osmoderma lassallei*	EN	
Scarabaeidae Dynastinae	*Calicnemis latreillei*	EN	yes
Scarabaeidae Dynastinae	*Calicnemis obesa*	EN	
Zopheridae	*Diodesma besucheti*	EN	yes
Zopheridae	*Pycnomerus italicus*	EN	yes
Zopheridae	*Tarphius besucheti*	EN	yes
Zopheridae	*Xylolaemus fasciculosus*	EN	
Buprestidae	*Buprestis splendens*	VU	
Cerambycidae	*Anaglyptus zappii*	VU	yes
Cerambycidae	*Callidium cedri*	VU	yes
Cerambycidae	*Clytus clavicornis*	VU	yes
Cerambycidae	*Clytus triangulimacula*	VU	yes
Cetoniidae	*Chromovalgus peyroni*	VU	yes
Cetoniidae	*Protaetia mirifica*	VU	
Cetoniidae	*Protaetia sardea*	VU	yes
Cleridae	*Enoplium doderoi*	VU	yes
Cleridae	*Thanasimodes dorsalis*	VU	yes
Elateridae	*Ampedus corsicus*	VU	yes
Eucnemidae	*Melasis fermini*	VU	yes
Lucanidae	*Dorcus musimon*	VU	yes
Lucanidae	*Lucanus busignyi*	VU	yes
Mycetophagidae	*Esarcus baudii*	VU	yes
Mycetophagidae	*Esarcus fiorii*	VU	yes
Mycetophagidae	*Esarcus franzi*	VU	yes
Rhysodidae	*Clinidium canaliculatum*	VU	yes
Scarabaeidae Euchirini	*Propomacrus bimucronatus*	VU	
Tetratomidae	*Tetratoma tedaldi*	VU	yes
Zopheridae	*Nosodomodes syriacus*	VU	yes
Zopheridae	*Tarphius oulmesensis*	VU	yes

3.3 Near Threatened species

Near Threatened species are those that are close to qualifying for a threatened category and may do so in the near future. The 29 species included in this category represent 9% of the total saproxylic beetles assessed in the region. Closed monitoring, and if possible conservation management, are essential to reduce the likelihood of population decline and/or habitat loss in these species. Eighteen of the 29 Near Threatened species are endemic to the region. Some species, such as *Esarcus abeillei* and *Diodesma denticincta*, present in France and Italy, and *Esarcus leprieuri*, found in Algeria and Tunisia, are flightless and thus, due to their weak dispersal ability, subject to local disappearance in the face of inadequate forest management or habitat degradation, or in the case of wildfires in their distribution range. More limited information is available on the population size of other species which mainly occur in North Africa, such as *Calchaenesthes sexmaculata* and *Chlorophorus favieri*, because records of them are very scarce due to low sampling activity.

Rare and insular species face potential threats such as wood removal, used as a remedy for preventing fires in Sardinia (*Ampedus melonii*), overgrazing and conversion of natural habitats to arable land or urbanization in Crete (*Stenopterus creticus*), and the increase of forests fires and urbanization in Cyprus (*Purpuricenus nicocles*). Even though very little is known about *Enoplium serraticorne*, due to its cryptic nature, the population of this species is suspected to be decreasing in size both in anthropogenic and natural habitats due to the removal of dead wood, including small and dry branches on the soil in trees.

Some endemic eastern Mediterranean species are rare and localised, with small and isolated subpopulations, making them prone to decline due to the reduced probability of recolonisation (*Stenopterus atricornis*, *Clytus taurusiensis*, *Molorchus juglandis*) in the event of threats such as urbanization, conversion of semi-natural habitats into pine plantations (*Chlorophorus yachovi*), intensive land-use such as overgrazing and wood-cutting (*Clytus kabateki*), and forest fires (*Lucanus laticornis*).

Other taxa which are apparently more widely distributed, such as *Triplax melanocephala*, found in southern Europe and northern Africa, are associated with micro-habitats such as forest litter, which are currently threatened by human activity, including collection of dead wood for fuel, intensive forestry, overgrazing, and forest fires.

3.4. Data Deficient species

A large proportion (41%; 131 species) of the species assessed are classed as Data Deficient, more than three fourths of them (77%) being endemic. The main reason for such a classification is the lack of any additional records since their description, very limited ecology and population data and, in particular cases, a need of taxonomic revision. Some occur nowadays in conflict areas, which makes access difficult for researchers.

Also, more than half (52%; 101 species) of the endemic species are listed as Data Deficient, which is a larger percentage than for the total of saproxylic beetles included in the same category (41%, 131 species); a result which reflects the need to increase the understanding of these species with a restricted distribution range.

3.5. Least Concern species

In the Mediterranean region, almost one third (31%; 98 species) of the saproxylic beetle species are listed as Least Concern (LC); they are not considered to be threatened at present or in the foreseeable future.

The majority of saproxylic beetles are affected in one way or another by threats linked to traditional practices of forest management (for example, removal of dead wood) or natural system modification (e.g. forest fires) in the Mediterranean region. Therefore, despite the fact that they are generally abundant, relative widespread, and/or resilient to other current threats and pressures, many of these non-threatened species will still benefit from habitat conservation management actions and further research, particularly on their natural history and population status.

Greater Capricorn beetle *Cerambyx cerdo*. Listed as Least Concern. Photo ©Jiri Schlaghamersky.

LEAST CONCERN

LC

Cerambyx carinatus. Listed Least Concern. Photo © Nikola Rahme

3.6. Non-native species

The black borer *Apate monachus* and the Monkeypod round-headed borer *Xystrocera globosa* are good examples of invasive saproxylic species in the Mediterranean region. Xystrocera globosa was described from South-East Asia in Singapore and can be considered to have an almost cosmopolitan distribution nowadays. *Apate monachus* is suspected to come from tropical Africa and naturalized in the Mediterranean region and South America during the 15-10th centuries.

3.7. Spatial distribution of species

Patterns of species richness were mapped by counting the number of species in each individual unit (a hexagonal grid composed of individual units) to create the corresponding distribution maps. Patterns of threatened species richness were mapped by counting the number of threatened species (categories CR, EN, VU at the Mediterranean regional level) in each individual unit. Patterns of endemic species richness were mapped by counting the number of species in each cell (or cell section for coastal species) that were flagged as being endemic to the Mediterranean region as defined in this project.

Centres of species richness

The area containing the highest richness was identified in the eastern Mediterranean **mountain ranges between southern Turkey and northern Syria**, (Figure 6), which supports an estimated 142 species of saproxylic beetles and 44% of the regional total assessed. The majority of these species also inhabit the adjacent region of **Levant**, which hosts a total of 74 species and 23% of the total.

In southeastern Europe, **Greece** also stands out for their high biodiversity with a fourth of the species (79 species) being present. Also, up to 45 (14%) species occur in the Provence-Alpes-Côte d'Azur region in **southern France** and 40 (12%) in the **Istria Peninsula of Croatia**.

Italy´s high saproxylic beetle diversity is also remarkable (64 species; 20% of the total assessed), particularly in the **regions of Lazio**, a highly prospected region for this group, **Basilicata, Calabria** (from Aspromonte to the Pollino massif), and **Sicily** (Carpaneto *et al.* 2015).

In Northern Africa, the **Tell Atlas and Aures Mountains** (in northern part of Algeria and Tunisia) host 66 species, corresponding to 21% of the total assessed, while **the Rif and parts of the Middle Atlas Mountains** in Morocco, together are home to 49 species (15% of the assessed).

The availability of climatic zones in these areas makes it possible the occurrence of a larger number of species adapted to different habitats. In many cases, these areas have been traditionally regarded as refugia in the Mediterranean region.

Centres of endemic species richness

The highest numbers of endemic species are found in **the southern coast of Turkey, the Taurus Mountains, and the Levant** mainly on the border between Turkey and Syria (69 species; 35% of all the endemics to the region), and in the North African Maghreb, particularly in the **Tell Atlas region** in northern Algeria and Tunisia (40 species; 20% of all endemic) (Figure 7).

Centres of threatened species richness

Most of the threatened species are confined to the **Middle Atlas** region in Morocco, the **Tell Atlas** in northern Algeria and Tunisia, the **Taurus Mountains** in the Turkish province of Mersin, the **Calabrian peninsula** in southern Italy, **the Levantine Syria and Lebanon** in the eastern Mediterraean, and the two large islands of **Sardinia** and **Corsica** (Figure 8).

Morocco, Algeria and Tunisia are home to 30% of all the threatened taxa (18 species): *Bothrideres interstitialis, Callidium cedri, Isotomus theresae, Neomarius gandolphii, Poecilium gudenzii, Pseudomyrmecion ramalinum, Semanotus algiricus, Vesperella maroccana, Gnorimus baborensis, Calicnemis latreillei, Calicnemis obesa, Ampedus rifensis, Triplax castanea, Dorcus musimon, Diodesma besucheti and Xylolaemus fasciculosus, Tarphius oulmesensis* and *Thanasimodes dorsalis.*
The Taurus Mountains support 19% (12 species) of the total regionally threatened taxa: *Glaphyra tenuitarsis, Poecilium kasnaki, Chromovalgus peyroni, Osmoderma brevipenne, Protaetia mirifica, Ectamenogonus montandoni, Tetrigus cyprius, Triplax emgei, Propomacrus bimucronatus, Dorcus peyronis, Lucanus busignyi,* and *Nosodomodes syriacus*.

Levantine Syria and Lebanon host 16% (10 species) of the threatened species: *Dastarcus libanicus, Callidium libani, Chromovalgus peyroni, Protaetia mirifica, Ectamenogonus montandoni, Tetrigus cyprius, Propomacrus bimucronatus Dorcus peyronis, Nosodomodes syriacus* and *Xylolaemus fasciculosus*,

The Calabrian peninsula (in southern Italy) supports 10 species of threatened saproxylic beetles (16%): *Buprestis splendens, Anaglyptus zappii, Clytus triangulimacula, Enoplium doderoi, Cucujus tulliae, Esarcus fiorii, Clinidium canaliculatum, Tetratoma tedaldi, Pycnomerus italicus* and *Xylolaemus fasciculosus*.

Up to ten threatened saproxylic beetles occur in **Corsica and Sardinia**: Opi*lo orocastaneus, Enoplium doderoi, Protaetia sardea, Calicnemis latreillii, Calicnemis obesa, Ampedus corsicus, Ectamenogonus montandoni, Stenagostus sardiniensis, Dorcus musimon* and *Xylolaemus fasciculosus*.

Centres of Data Deficient species richness

There is a lack of information regarding distribution, population size, and trends, especially in the **eastern Mediterranean** countries of Turkey and Syria (Figure 9). Up to 65 species listed as Data Deficient are found in this area, which represent half (50%) of the total assessed in this category.

Stenopterus flavicornis. Distributed in the north east Mediterranean, it is usually found in deciduous trees. Listed as Least Concern © Nikola Rahme.

Figure 6. **Species richness of saproxylic beetles in the Mediterranean region.**

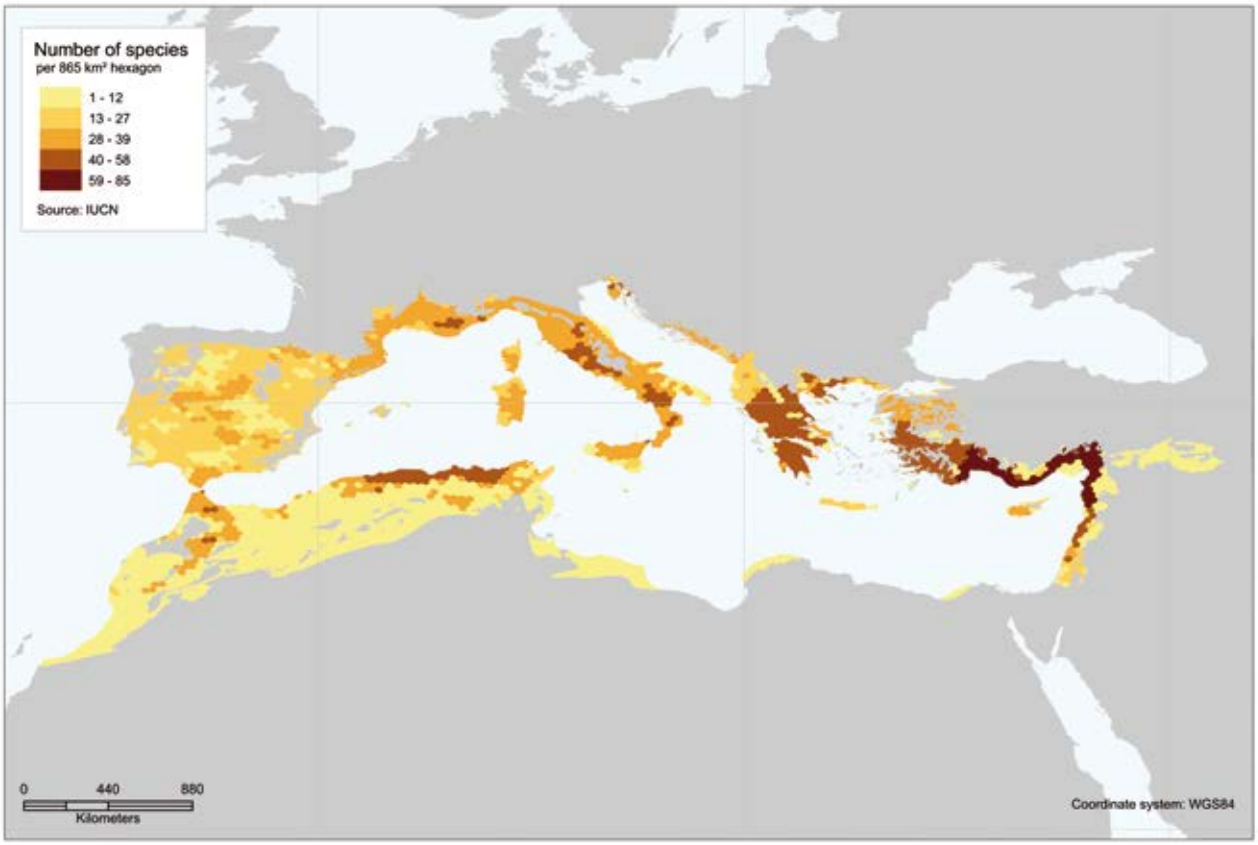


Figure 7. **Species richness of endemic saproxylic beetles in the Mediterranean region.**

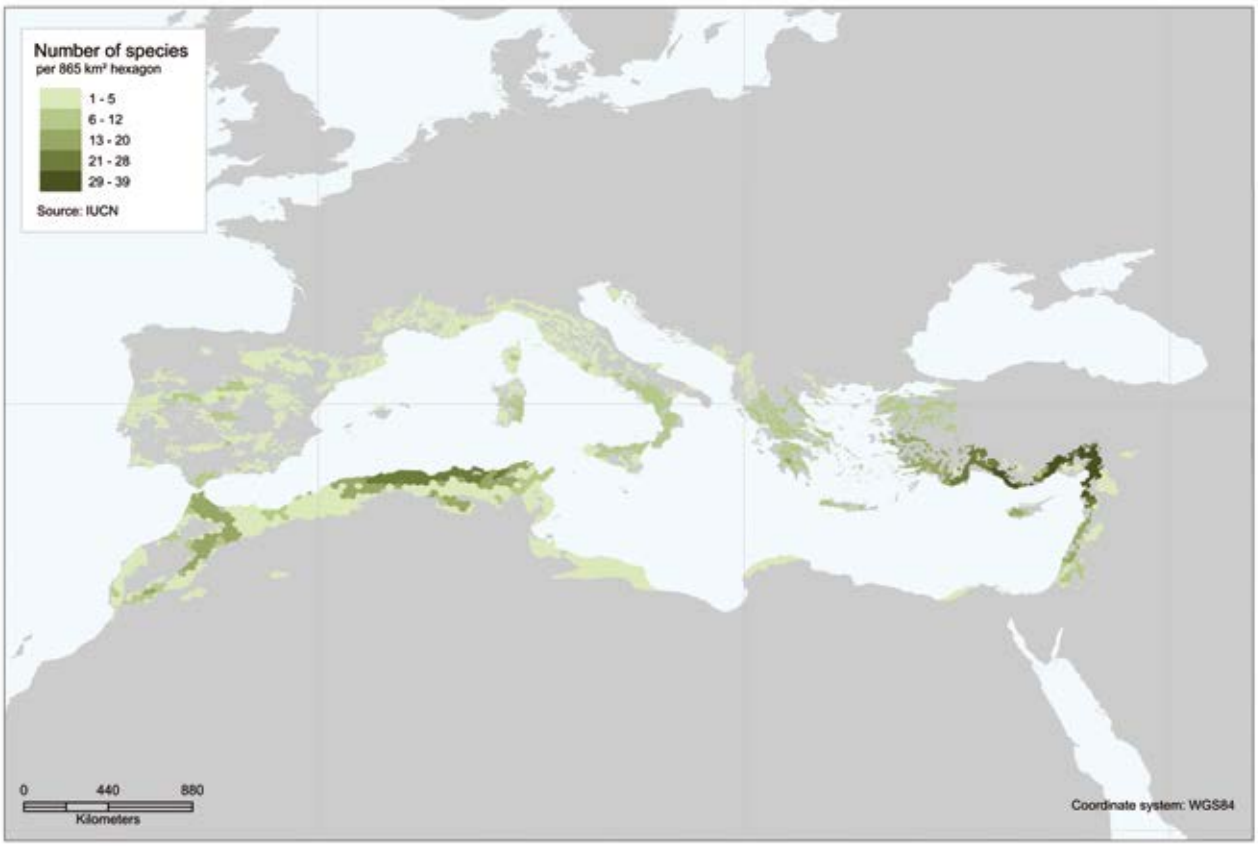


Figure 8. **Distribution of threatened saproxylic beetles in the Mediterranean region.**

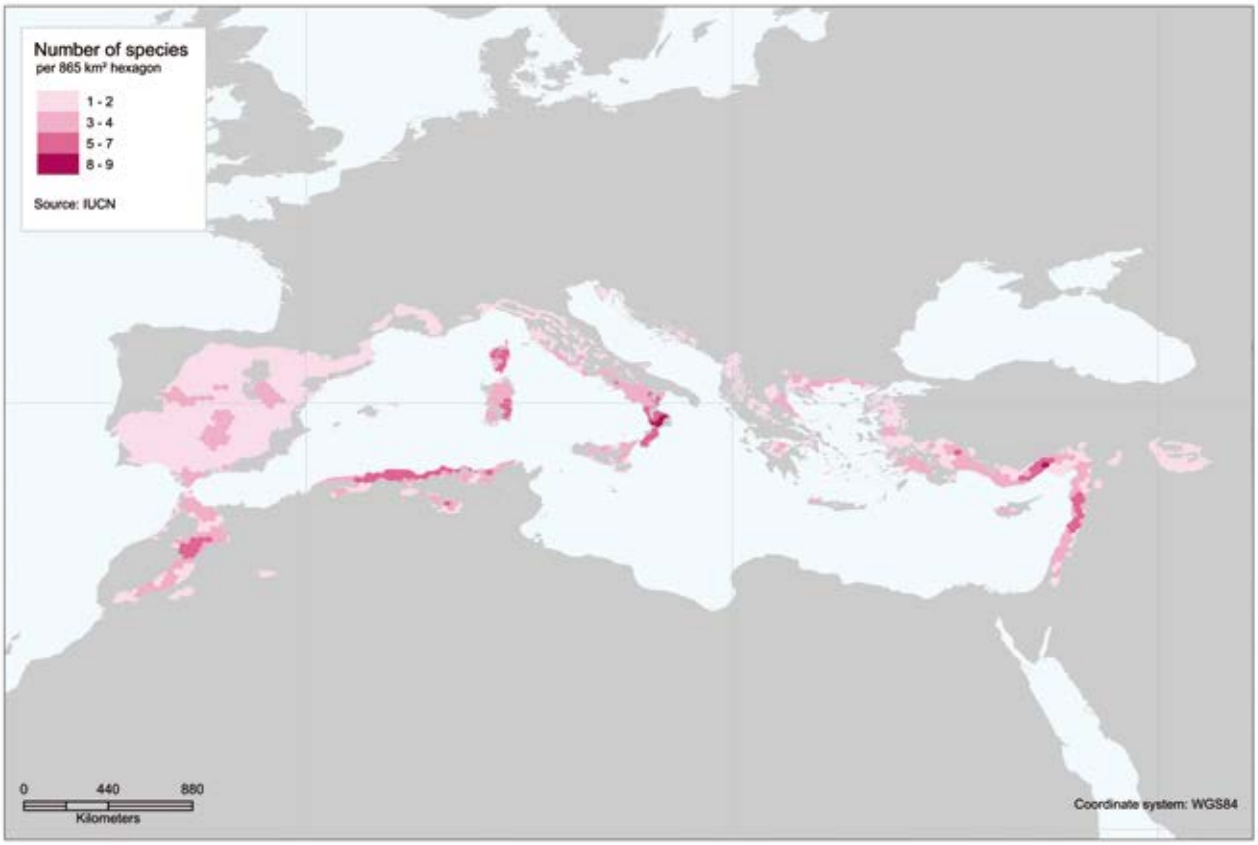
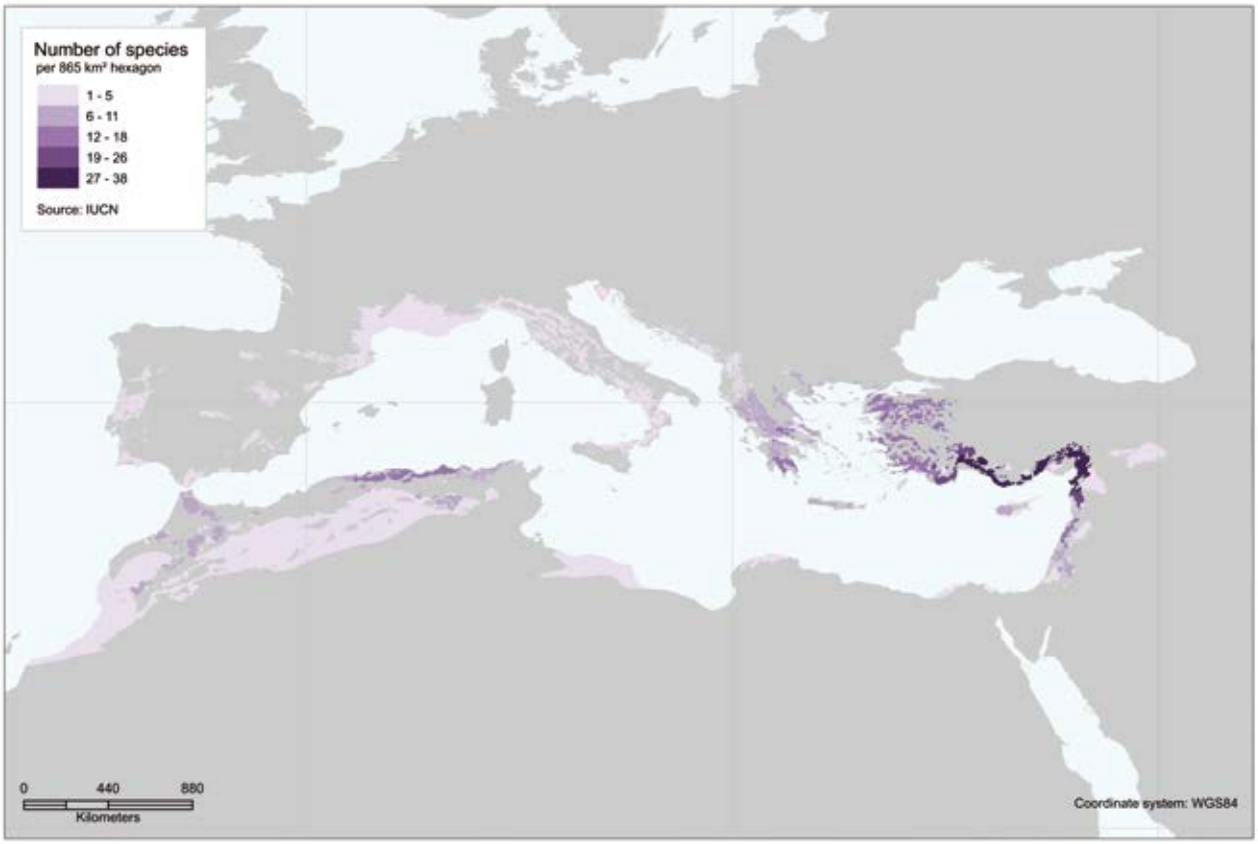


Figure 9. **Distribution of Data Deficient saproxylic beetles in the Mediterranean region.**



Temnochila caerulea is a generalist predator living in coniferous and broad-leaved trees, it is listed as Least Concern. Photo ©Nikola Rahme.

3.8. Major threats to saproxylic beetles in the Mediterranean region

A summary of the major threats to saproxylic beetles in the Mediterranean, according to the IUCN Classification Scheme of Threats, is presented in Figure 10, as well as the number of threatened (62) and non-threatened (258) species.

All assessed taxa are threatened by logging and wood harvesting, which constitutes the most important impact to both threatened and non-threatened taxa, affecting to 49 of the 62 threatened taxa, and 136 taxa in total. Forest fires are another widely distributed threat in the region, which has a direct effect on the availability and quality of suitable habitat for up to 60 saproxylic beetle taxa, 31 of them being threatened species.

Land use changes associated with agricultural expansion, timber plantations, conversion to pastureland and grazing by livestock, are also key threats contributing to the decline of beetle populations. In addition, urban development has lead to an irreversible destruction of the habitat of 18 taxa, more than half of them threatened at Mediterranean level. An example of this are large tourism development projects, which have become a reason for concern in coastal areas of France, Spain, Italy and Turkey as they involve concreting as well as massive and rapid urbanization of the littoral space. These changes alter tree population age structures and tree density of the host species that saproxylic beetles need to complete their life cycle, an ecological relationship that for some particular taxa is highly specific and key to their survival.

Other ecosystem modifications and in particular activities of intensive forest management for example, the removal of old dead trees, clearing of dead wood, dry branches on the soil and on trees, burning, and filling rot holes with concrete or other materials, are strongly detrimental to Mediterranean saproxylic beeties. Moreover, in many areas, regeneration of suitable habitat across species' distribution range is very sparse with no replacements existing once the veteran trees die. In some cases, the abandonment of traditional grazing regimes may lead to a decrease in the number of trees suitable for the specie to live.
Climate change and severe weather, especially an increasing frequency of droughts, habitat shifting and alteration, and extreme temperatures severely affect nine of the assessed saproxylic beetle species, six of which are threatened. This trend is likely to worsen in the future as the effects of climate change increase (Botkin *et al.* 2007, Dawson *et al.* 2011).

A dead fallen tree in Talassemtane National Park, the perfect habitat for many saproxylic beetle species ©IUCN.

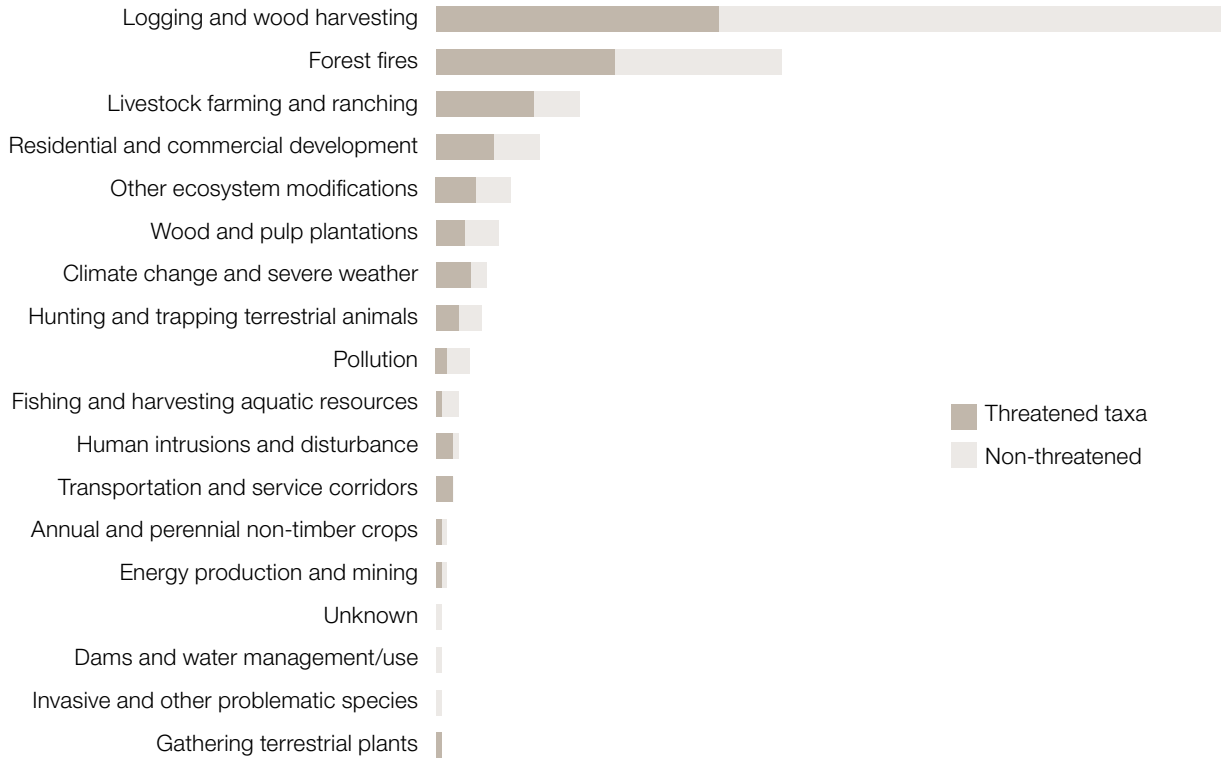
A few of the larger and more colourful species could be subject to unregulated collection of specimens to trade and sell, such as the Endangered Italian endemics *Gnorimus decempunctatus*, and *Osmoderma cristinae*, and the Vulnerable jewel beetle *Buprestis splendens*, and Violet rose chafer *Protaetia mirifica*.

Some species are also potentially threatened by human intrusions and disturbance due to tourism and recreation activities, or activities related to war and military exercises.

Agricultural pollution by pesticides, infrastructure development energy production and mining have also been identified to have a negative impact.

Due to fragmented distribution, some of these threats may be increasing isolation between subpopulations, as the dispersal ability of most individuals is limited to a few hundred meters.

Figure 10. **Summary of threats to all assessed species native to the Mediterranean region**



Chapter 4. Recommendations for priority conservation measures

4.1. International and regional instruments relevant to the conservation and management of Mediterranean saproxylic beetles 35

4.2. The Bern Convention on the Conservation of European Wildlife and Natural Habitats 36

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The effects of forest fire in Sierra de Lújar, Spain © Claire Baudoux.

Despite their extraordinary biodiversity, Mediterranean temperate forests are facing major biodiversity loss due to deforestation and inadequate management, gradually becoming more fragmented and denaturalized. Even though they are still very little known and often neglected, many species of saproxylic beetles living in these forests develop in the trunks and branches of mature and veteran trees, such as oaks and pines, as well as in small to large cavities of trees and stumps at different stages of decomposition. Habitat fragmentation is particularly decreasing long-term survival probability for most of these species because of their limited dispersal ability and microhabitat specialization.

Dead wood and standing dead trees in forests have traditionally been seen as a symptom of neglect and poor management that needed to be removed to avoid risk of fire and prevent the spread of disease to healthy trees. Other justifications for putting in place traditional restoration activities such "salvage logging", which consists on removing all the wood mass remaining after forest fires – dead wood makes it more difficult to access forested areas for exploitation of natural resources through activities such as gathering mushrooms, berries, chestnuts, woods, etc., or to reduce the risk of tourists and land users from accidents by falling trees or large branches (La Fauci *et al*. 2006, Carpaneto *et al*. 2015). However, we now

know these are general misconceptions, for example, rotting wood is generally humid and therefore unlikely to be affected by fires, or that "pathogenic" organisms, especially fungi, live mostly on decaying wood and do not attack healthy trees (Carpaneto *et al*. 2015) - and scientific information is key to reduce the negative impacts of these activities on biodiversity.

Along with its importance for the survival of saproxylic beetles, dead wood plays a key role in the forest ecosystem, providing a number of suitable microhabitats for thousands of species (Marchetti and Lombardi 2006) and has been identified as a carbon monoxide storing pool (Watson *et al*. 2000). The development of forest resource exploitation plans should not overlook how essential biodiversity conservation is for its maintenance (Carpaneto *et al*. 2015).

Conservation planners should take into consideration that saproxylic beetle communities are more likely to successfully develop when there exists a range of diverse habitats, including trees of different age classes and dead wood in various levels of decomposition, and that each tree is important, as one single tree could host not only different species of beetle but also various generations of the same species. Also, the formation of dead wood should be able to ensure a succession of various communities at different stages of their life cycle.

Several species, such us those of the genera *Lucanus*, *Oryctes*, and *Cerambyx* disperse through flight and therefore would benefit from the maintenance of natural corridors, for example, keeping old trees standing on the edges of agricultural landscapes or patches of forests. Special attention should be paid to ensure these corridors are away from streets where, due to the slow movement of the beetles, could be threatened by traffic (Van der Sluis *et al*. 2004, Carpaneto *et al*. 2015).

The principal conservation measures for the protection of saproxylic beetles in the Mediterranean are to promote research initiatives to better understand the status of species, to maintain habitat quality and structural complexity, and to implement education and law enforcement programs to reduce wood removal and forest fires though outreach, habitat and resources protection, including protected areas, and to maintain connectivity.

Some protection measures are currently in place, either for species or ecosystems, in the Mediterranean region. National protection status varies by country, and there is an urgent need to implement conservation actions. The following section presents current conservation initiatives, as well as priority recommendations for the conservation of Mediterranean saproxylic beetle biodiversity. Also, selected LIFE projects have been implemented in the European Union for the conservation management of saproxylic beetles and their habitats (see Nieto and Alexander 2010 for more detailed information).

One overall conclusion of this evaluation was the limited amount of information that is currently available for some areas of the Mediterranean region, particularly in the eastern Mediterranean.

Carpaneto *et al*. (2015) highlight a series of key conservation recommendations for saproxylic beetles in Italy also applicable to Mediterranean countries, including i) habitat management of natural forests according to good practices, for example, favour tree heterogeneity and uneven-aged composition, promote good environmental forest edges and corridors, not to remove fallen trees, also along beaches and sand dunes; ii) promote initiatives aimed at improving the quality of forest ecosystems in general, guaranteeing a significant portion of mature forest, and (if necessary) using artificial techniques for accelerating the formation of suitable breeding sites for the saproxylic beetles; iii) preserve and restore relict forests; iv) identify and support synergies for preservation or implantation of trees, also in agricultural landscapes; v) preserve forest fragments in urban green spaces.

Lacon punctatus is an active predator feeding on larvae and nymphs found in decaying trees, usually conifers. Listed as Least Concern. Photo © Nikola Rahme

RED LIST
LEAST CONCERN
LC

4.1. International and regional instruments relevant to the conservation and management of Mediterranean saproxylic beetles

Mediterranean countries are signatories to a number of important conventions aimed at conserving biodiversity. The following conventions are relevant to the conservation and management of the Mediterranean insect fauna under various regional conventions, which are summarized in Table 6. Four of the saproxylic beetles assessed as threatened in the Mediterranean are listed in the appendices of regional conventions: *Buprestis splendens*, *Propomacrus cypriacus*, *Osmoderma cristinae*, and *Osmoderma lassallei*. Recent genetic studies have led to the recognition of *Osmoderma cristinae* and *Osmoderma lassallei* as good species separated from *O. eremita*. Although the Bern Convention and Habitat Directive have not incorporated this split yet, these species are presented here under the complex of *O. eremita*, which represents five species as used in the Red List. The flat bark beetle *Cucujus cinnaberinus*, also present in these directives, was excluded from this report because its distribution in the Mediterranean region is considered marginal with more than 25% of its global population occurring outside the region.

The Bern Convention is a binding international legal instrument that aims to conserve wild flora and fauna and their natural habitats and to promote European cooperation towards that objective. It covers all European countries and some African states. The Habitats Directive is one of the EU's two directives related to wildlife and nature conservation. There are five Mediterranean species of saproxylic beetles listed under Annex II (strictly protected species) of the Bern Convention, and Annexes II (species requiring designation of Special Areas of Conservation) and IV (species in need of strict protection) of the Habitats Directive.

Some saproxylic beetles are targeted because they are considered harmful to forest health, as is the case of the longhorn beetle *Cerambyx cerdo*, usually associated with mature oaks. A priority species listed in Annex II and IV of the Habitats Directive, is considered a plague in some countries (Carpaneto *et al.* 2015), and eradication strategies are directly threatening other saproxylic taxa which coexist in specific tree structures such as hollows, dead branches, bare bark, fungal fruiting bodies, etc.

4.2. The Bern Convention on the Conservation of European Wildlife and Natural Habitats

The Bern Convention aims to conserve wild flora and fauna and their natural habitats, especially where the cooperation of several States is required (Council of Europe 2016). The main aim of the EC Habitats Directive is to promote the maintenance of biodiversity. The Directive requires Member States to take measures to maintain or restore natural habitats and wild species (listed in its Annexes) to a favourable conservation status, introducing robust protection for those habitats and species of European importance. This requires measures to be taken to maintain or restore to favourable conservation status in their natural range, habitats and species of wild flora and fauna of Community interest and listed in Annexes to the Directive (Council of Europe 2016).

The Bern convention was one of the first international treaties that recognised the importance of invertebrates as potential bio-indicators for the condition of habitats. The Standing Committee to the Bern convention established the Group of experts on Conservation of Invertebrates in December 1989, and it held its first meeting in April 1990.

According to Nieto and Alexander (2010) considerable work has been undertaken within the Convention for the protection of saproxylic beetle species. After the publication of Speight (1989), the Convention adopted a recommendation on the protection of saproxylic organisms and their biotopes[4]. This was followed by a publication of Koomen and van Helsdingen (1993) in which European ecosystems with high importance for saproxylic beetles were listed. In 2007, and commissioned by the Council of Europe, a European strategy for the conservation of invertebrate animals was produced (Haslett 2007) and was approved by Contracting Parties[5]. However, this strategy only considered the conservation of saproxylic beetles under Forestry land, and did not acknowledge their importance and conservation needs within agricultural and urban land. No action plans were developed for saproxylic beetles in the framework of this Convention.

In particular five species listed in Appendix II (strictly protected species) and one species listed in Appendix III (protected species) of the Bern Convention are included in this Red List assessment (Table 6). However *Osmoderma eremita* is a species listed on Appendix II of the Bern Convention and has very recently been proposed to be four separate species (*Osmoderma barnabita*, *Osmoderma brevipenne*, *Osmoderma cristinae*, and *Osmoderma lassallei*). There is ongoing debate as to whether or not *Osmoderma italicum* constitute a valid species, separated by *O. eremita*, but for the purpose of this assessment we are following the most up-to-date taxonomy that considers it a synonym of *O. eremita* (Audisio *et al.* 2007, 2009). While this split remains controversial, it was decided to assess *O. barnabita*, *O. brevipenne*, *O. cristinae*, and *O. lassallei* as separate species for the purposes of the Red List. The name currently used in the Convention thus represents four species as used in the Red List.

[4] Council of Europe Committee of Ministers, Recommendation No. R (88) 10 adopted on 3 June 1988, on the protection of saproxylic organisms and their biotopes.
[5] Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats, Recommendation No. 120 (2006) adopted on 30 November 2006, on the European Strategy for the Conservation of Invertebrates.

Table 6. Mediterranean saproxylic beetles species listed on international annexes and regulations.

		International and Regional Legal Instrument	European Legal Instrument
Species	IUCN Red List category at the Mediterranean level	Bern Convention (b) Convention on the Conservation of European Wildlife and Natural Habitats (1979)	EU Habitats Directive (c)
Buprestis splendens	VU	II	II/IV
Cerambyx cerdo	LC	II	II/IV
Rosalia alpina	LC	II	II/IV
Osmoderma cristinae	EN	II	II/IV[1]
Osmoderma lassallei	EN	II	II/IV[1]
Propomacrus cypriacus	CR		II/IV
Lucanus cervus	LC	III	II
Lucanus pontbrianti	DD		II[2]

[1] As part of *Osmoderma eremita*.
[2] As part of *Lucanus cervus*
(b) Signed and ratified by all Mediterranean States in the study, except Algeria, Egypt, Syria, Israel, and Lebanon. Appendix II – Strictly protected fauna species. Appendix III - Protected fauna species.
(c) Council Directive 92/43/EEC. Must be implemented in all European States of the Mediterranean, Annex II lists species requiring designation of Special Areas of Conservation; Annex IV lists species in need of strict protection.

4.3. EU Habitats Directive

The EU Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right (Council of Europe 1992). The Habitats Directive is also known as Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora. It is a European Union directive adopted in 1992 as EU response to the Bern Convention. It is one of the EU's two directives related to wildlife and nature conservation, the other being the Birds Directive (http://ec.europa.eu/environment/nature/legislation/ habitatsdirective/index_en.htm).

Purpuricenus dalmatinus.
Listed as Least Concern.
Photo © Nikola Rahme.

NEAR THREATENED
NT

Farsus dubius. Listed as Near Threatened. Photo © Nikola Rahme.

DATA DEFICIENT
DD

Lioderina linearis is found in deciduous and coniferous trees. The current population trend is decreasing and is listed as Data Deficient. Photo © Nikola Rahme

Chapter 5. Conclusions and recommendations

This report represents the first comprehensive regional IUCN Red List assessment of the saproxylic beetle fauna of the Mediterranean region. Five hundred and seven Mediterranean species were examined for their distribution ranges and 320 endemic or almost endemic to the region were assessed for their risk of extinction (Appendix 1). It is estimated that 32%* of the species are threatened in the region. Sixty-two out of 320 species evaluated are considered to be threatened, including 0.6% Critically Endangered, 12% Endangered, and 7% Vulnerable. For 41% of the assessed species, information was insufficient and therefore they were listed as being Data Deficient in the Mediterranean region. These taxa should be acknowledged as being potentially threatened and highlighted as priorities for additional research and funding. Although limited data availability is often cited as a problem, it should not, however, be used to justify the lack of management.

Saproxylic beetles play an important role in the ecosystem´s health and food chain, particularly in nutrients recycling, as they depend on or are involved in wood decay. However, the details on their role are still largely misunderstood and the current information gaps on these species´ population status, trends, and distribution are a reflection on how little we still know about them.

Exploitation from forestry and wood harvesting, increased frequency of forest fires, and overall changes in land use (urbanization, agricultural intensification, and livestock grazing) as well as activities of intensive forest management (removal of old dead trees, clearing of dead wood) are the most important threats to saproxylic beetles in the Mediterranean region, which impact almost all of the presented species.

The urgent key measures needed to improve the conservation status of the saproxylic beetles in the Mediterranean are:

- Changes in traditional habitat management strategies and policy implementation to reinforce the importance of dead wood for crucial stages of the life cycle of saproxylic beetles.
- Improvement of forest management through increasing the importance of native tree species also in commercial forestry, enriching pine plantations with broadleaved tree species and allowing trees for natural aging within the stands.
- Reinforce field research to increase the knowledge on the distribution, population, and natural history of species, particularly those taxa listed as Data Deficient.
- In order to stop further decline in the Mediterranean environments, threatened species should be included in the national and regional catalogues and their protection enforced through policies and designating area and habitat protection, with particular emphasis on endemic threatened taxa and biodiversity hotspots.
- Increase the funding mechanisms, for example, EU LIFE programme to conservation projects on threatened saproxylic species included in the IUCN Red List
- Strengthen regional collaboration between Mediterranean scientists, amateurs engaged in entomology, and national and local entomological societies specialized in this functional group or the taxonomic groups involved so that information gaps can be filled in the countries where least is known, and therefore a more comprehensive picture of the status of these species can drawn at national, regional, and global level.
- Regularly update with new records, as these become available, the information on native Mediterranean saproxylic beetles.
- Raise public awareness on the importance of dead wood and saproxylic beetles in the Mediterranean forests to conserve healthy and balanced ecosystems, and the services they provide.

All data generated by this project and summarized in the present report are freely available. The assessments of all species included in this project are available on the IUCN Red List website (iucnredlist.org/mediterranean) and freely available to the public. This information is a base resource to assist in the prioritization of sites that contribute significantly to the global persistence of biodiversity at both regional and international levels, such as Key Biodiversity Areas (Langhammer *et al.* 2007) and Alliance for Zero Extinction sites (Ricketts *et al.* 2005). In addition, this information can guide decision makers in future development and environmental planning.

A strong and collaborative network of experts has been built through this project, which is essential for keeping the collated information regularly up-to-date and its effective integration within development and environmental planning processes. Efforts should be directed to keep and strength the links between IUCN and its partners, policy makers, regional decision makers and related organizations to use, maintain and strengthen this freely available knowledge and integrate it into future planning. Lessons learned from the process of integrating biodiversity information need to be disseminated to all stakeholders in a practical format that makes it easy to replicate the most successful methodologies.

* 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).

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Appendix 1.

Summary of regional IUCN Red List status of Mediterranean saproxylic beetles assessed

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Bostrichidae	*Amphicerus bimaculatus*	LC		
Bostrichidae	*Apate monachus*	NA		
Bostrichidae	*Bostrichus capucinus*	NE		
Bostrichidae	*Lichenophanes numida*	LC		endemic
Bostrichidae	*Lichenophanes varius*	NE		
Bostrichidae	*Phonapate uncinata*	NE		
Bostrichidae	*Psoa dubia*	LC		
Bostrichidae	*Psoa viennensis*	NE		
Bostrichidae	*Scobicia chevrieri*	LC		
Bostrichidae	*Scobicia pustulata*	LC		
Bostrichidae	*Sinoxylon perforans*	NE		
Bostrichidae	*Stenomera blanchardii*	DD		endemic
Bostrichidae	*Stephanopachys quadricollis*	LC		
Bostrichidae	*Xylomedes cornifrons*	LC		
Bostrichidae	*Xylomedes coronata*	LC		endemic
Bostrichidae	*Xylomedes turcica*	DD		
Bostrichidae	*Xylopertha praeusta*	LC		
Bostrichidae	*Xylopertha retusa*	NE		
Bostrichidae	*Xyloperthella picea*	NE		
Bothrideridae	*Bothrideres interstitialis*	EN	B2ab(iii)	
Bothrideridae	*Dastarcus libanicus*	EN	B2ab(iii)	
Bothrideridae	*Dastarcus turcicus*	DD		
Bothrideridae	*Ogmoderes angusticollis*	LC		endemic
Bothrideridae	*Oxylaemus variolosus*	NE		
Buprestidae	*Buprestis splendens*	VU	B2ab(iii)	
Cerambycidae	*Aegosoma scabricorne*	NE		
Cerambycidae	*Anaglyptus croesus*	DD		endemic
Cerambycidae	*Anaglyptus gibbosus*	LC		
Cerambycidae	*Anaglyptus luteofasciatus*	EN	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Anaglyptus mysticus*	NE		
Cerambycidae	*Anaglyptus praecellens*	EN	B1ab(iii,v)+2ab(iii,v)	endemic
Cerambycidae	*Anaglyptus zappii*	VU	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Anatolobrium eggeri*	DD		endemic
Cerambycidae	*Aromia moschata*	NE		
Cerambycidae	*Axinopalpis barbarae*	DD		endemic
Cerambycidae	*Axinopalpis gracilis*	NE		
Cerambycidae	*Brachypteroma ottomanum*	LC		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Cerambycidae	*Calchaenesthes oblongomaculata*	DD		
Cerambycidae	*Calchaenesthes sexmaculata*	NT		endemic
Cerambycidae	*Callergates gaillardoti*	LC		
Cerambycidae	*Callidium aeneum*	NE		
Cerambycidae	*Callidium cedri*	VU	B2ab(ii,iii)	endemic
Cerambycidae	*Callidium coriaceum*	NE		
Cerambycidae	*Callidium libani*	EN	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Callidium syriacum*	LC		endemic
Cerambycidae	*Callimoxys gracilis*	LC		
Cerambycidae	*Callimus abdominalis*	LC		
Cerambycidae	*Callimus akbesianus*	DD		endemic
Cerambycidae	*Callimus angulatus*	NE		
Cerambycidae	*Cerambyx carinatus*	LC		
Cerambycidae	*Cerambyx cerdo*	LC		
Cerambycidae	*Cerambyx dux*	LC		
Cerambycidae	*Cerambyx miles*	LC		
Cerambycidae	*Cerambyx nodulosus*	LC		
Cerambycidae	*Cerambyx paludivagus*	DD		endemic
Cerambycidae	*Cerambyx scopolii*	NE		
Cerambycidae	*Cerambyx welensii*	NT		
Cerambycidae	*Chlorophorus aegyptiacus*	LC		
Cerambycidae	*Chlorophorus convexifrons*	DD		
Cerambycidae	*Chlorophorus dinae*	LC		endemic
Cerambycidae	*Chlorophorus favieri*	NT		endemic
Cerambycidae	*Chlorophorus figuratus*	NE		
Cerambycidae	*Chlorophorus glabromaculatus*	LC		
Cerambycidae	*Chlorophorus glaucus*	LC		
Cerambycidae	*Chlorophorus gratiosus*	LC		endemic
Cerambycidae	*Chlorophorus herbstii*	NE		
Cerambycidae	*Chlorophorus nivipictus*	LC		endemic
Cerambycidae	*Chlorophorus pelletieri*	DD		endemic
Cerambycidae	*Chlorophorus pilosus*	NE		
Cerambycidae	*Chlorophorus rigenbachi*	DD		endemic
Cerambycidae	*Chlorophorus ruficornis*	LC		
Cerambycidae	*Chlorophorus sartor*	NE		
Cerambycidae	*Chlorophorus varius*	NE		
Cerambycidae	*Chlorophorus yachovi*	NT		endemic

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Cerambycidae	*Clytus ambigenus*	DD		endemic
Cerambycidae	*Clytus arietis*	NE		
Cerambycidae	*Clytus ciliciensis*	LC		endemic
Cerambycidae	*Clytus clavicornis*	VU	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Clytus kabateki*	NT		endemic
Cerambycidae	*Clytus lama*	NE		
Cerambycidae	*Clytus madoni*	LC		endemic
Cerambycidae	*Clytus peyroni*	DD		endemic
Cerambycidae	*Clytus rhamni*	NE		
Cerambycidae	*Clytus taurusiensis*	NT		endemic
Cerambycidae	*Clytus triangulimacula*	VU	B2ab(iii)	endemic
Cerambycidae	*Clytus tropicus*	NE		
Cerambycidae	*Cyrtoclytus capra*	NE		
Cerambycidae	*Deilus fugax*	NE		
Cerambycidae	*Delagrangeus angustissimus*	LC		endemic
Cerambycidae	*Ergates faber*	NE		
Cerambycidae	*Glaphyra bassettii*	EN	B1ab(iii,v)+2ab(iii,v)	endemic
Cerambycidae	*Glaphyra kiesenwetteri*	NE		
Cerambycidae	*Glaphyra marmottani*	NE		
Cerambycidae	*Glaphyra tenuitarsis*	EN	B2ab(iii)	endemic
Cerambycidae	*Glaphyra umbellatarum*	NE		
Cerambycidae	*Gracilia minuta*	NE		
Cerambycidae	*Hesperophanes sericeus*	LC		
Cerambycidae	*Hylotrupes bajulus*	NE		
Cerambycidae	*Icosium tomentosum*	LC		
Cerambycidae	*Isotomus jarmilae*	EN	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Isotomus speciosus*	NE		
Cerambycidae	*Isotomus syriacus*	DD		endemic
Cerambycidae	*Isotomus theresae*	EN	B2ab(iii)	endemic
Cerambycidae	*Lampropterus femoratus*	NE		
Cerambycidae	*Leioderes kollari*	NE		
Cerambycidae	*Leioderes tuerki*	LC		endemic
Cerambycidae	*Lioderina linearis*	DD		
Cerambycidae	*Lucasianus levaillantii*	LC		
Cerambycidae	*Mesoprionus lefebvrei*	DD		
Cerambycidae	*Molorchus juglandis*	NT		endemic
Cerambycidae	*Molorchus minor*	NE		
Cerambycidae	*Monocladum aegyptiacum*	NE		
Cerambycidae	*Nathrius brevipennis*	NE		
Cerambycidae	*Neomarius gandolphii*	EN	B2ab(iii)	endemic
Cerambycidae	*Obrium brunneum*	NE		
Cerambycidae	*Obrium cantharinum*	NE		
Cerambycidae	*Penichroa fasciata*	LC		
Cerambycidae	*Phymatodes testaceus*	NE		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Cerambycidae	*Plagionotus arcuatus*	NE		
Cerambycidae	*Plagionotus detritus*	NE		
Cerambycidae	*Poecilium alni*	NE		
Cerambycidae	*Poecilium fasciatum*	LC		
Cerambycidae	*Poecilium gudenzii*	EN	B2ab(iii)	endemic
Cerambycidae	*Poecilium kasnaki*	EN	B2ab(iii)	endemic
Cerambycidae	*Poecilium lividum*	LC		
Cerambycidae	*Poecilium magnanii*	DD		endemic
Cerambycidae	*Poecilium puncticolle*	NE		
Cerambycidae	*Poecilium pusillum*	NE		
Cerambycidae	*Poecilium rufipes*	NE		
Cerambycidae	*Prinobius myardi*	LC		
Cerambycidae	*Prionus besikanus*	DD		
Cerambycidae	*Prionus coriarius*	NE		
Cerambycidae	*Procallimus distinctipes*	LC		endemic
Cerambycidae	*Pronocera angusta*	NE		
Cerambycidae	*Pseudomyrmecion ramalinum*	EN	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Pseudosphegesthes bergeri*	EN	B1ab(iii)+2ab(iii)	endemic
Cerambycidae	*Pseudosphegesthes cinerea*	LC		
Cerambycidae	*Pseudosphegesthes longitarsus*	DD		
Cerambycidae	*Purpuricenus barbarus*	DD		endemic
Cerambycidae	*Purpuricenus budensis*	LC		
Cerambycidae	*Purpuricenus caucasicus*	DD		
Cerambycidae	*Purpuricenus dalmatinus*	LC		
Cerambycidae	*Purpuricenus desfontainii*	LC		endemic
Cerambycidae	*Purpuricenus graecus*	LC		endemic
Cerambycidae	*Purpuricenus interscapillatus*	LC		
Cerambycidae	*Purpuricenus nicocles*	NT		endemic
Cerambycidae	*Purpuricenus nigronotatus*	DD		endemic
Cerambycidae	*Purpuricenus schurmanni*	DD		endemic
Cerambycidae	*Pyrrhidium sanguineum*	NE		
Cerambycidae	*Rhaesus serricollis*	NE		
Cerambycidae	*Ropalopus clavipes*	NE		
Cerambycidae	*Ropalopus eleonorae*	DD		endemic
Cerambycidae	*Ropalopus femoratus*	NE		
Cerambycidae	*Ropalopus insubricus*	LC		
Cerambycidae	*Ropalopus macropus*	NE		
Cerambycidae	*Ropalopus siculus*	NT		endemic
Cerambycidae	*Ropalopus varini*	LC		
Cerambycidae	*Rosalia alpina*	LC		
Cerambycidae	*Semanotus algiricus*	EN	B2ab(iii,v)	endemic
Cerambycidae	*Semanotus laurasii*	LC		
Cerambycidae	*Semanotus russicus*	LC		
Cerambycidae	*Semanotus undatus*	NE		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Cerambycidae	*Stenhomalus bicolor*	LC		
Cerambycidae	*Stenopterus ater*	LC		
Cerambycidae	*Stenopterus atricornis*	NT		endemic
Cerambycidae	*Stenopterus creticus*	NT		endemic
Cerambycidae	*Stenopterus flavicornis*	LC		
Cerambycidae	*Stenopterus kraatzi*	DD		
Cerambycidae	*Stenopterus mauritanicus*	LC		
Cerambycidae	*Stenopterus similatus*	DD		
Cerambycidae	*Stromatium unicolor*	LC		
Cerambycidae	*Tragosoma depsarium*	NE		
Cerambycidae	*Trichoferus bergeri*	CR	B1ab(iii,iv)	endemic
Cerambycidae	*Trichoferus fasciculatus*	LC		
Cerambycidae	*Trichoferus griseus*	LC		
Cerambycidae	*Trichoferus holosericeus*	LC		
Cerambycidae	*Trichoferus ilicis*	DD		endemic
Cerambycidae	*Trichoferus kotschyi*	DD		endemic
Cerambycidae	*Trichoferus pallidus*	NE		
Cerambycidae	*Vesperella maroccana*	EN	B2ab(iii,v)	endemic
Cerambycidae	*Xylotrechus antilope*	NE		
Cerambycidae	*Xylotrechus arvicola*	NE		
Cerambycidae	*Xylotrechus rusticus*	NE		
Cerambycidae	*Xystrocera globosa*	NA		
Cleridae	*Clerus mutillaeformis*	DD		endemic
Cleridae	*Dermestoides sanguinicollis*	NE		
Cleridae	*Enoplium doderoi*	VU	B2ab(ii,iii)	endemic
Cleridae	*Enoplium serraticorne*	NT	B2b(ii,iii)	
Cleridae	*Eucymatodera senegalensis*	NE		
Cleridae	*Flabellotilloidea bayonnei*	DD		
Cleridae	*Flabellotilloidea palaestina*	DD		endemic
Cleridae	*Flabellotilloidea vaulogeri*	DD		endemic
Cleridae	*Korynetes coxalis*	DD		endemic
Cleridae	*Korynetes geniculatus*	LC		endemic
Cleridae	*Korynetes pusillus*	LC		endemic
Cleridae	*Opilo abeillei*	DD		endemic
Cleridae	*Opilo barbarus*	LC		endemic
Cleridae	*Opilo cilicicus*	DD		endemic
Cleridae	*Opilo domesticus*	LC		
Cleridae	*Opilo orocastaneus*	EN	B2ab(ii,iii)	endemic
Cleridae	*Opilo taeniatus*	DD		
Cleridae	*Opilo tilloides*	DD		endemic
Cleridae	*Phloiocopus andresi*	DD		
Cleridae	*Syriopelta funebris*	DD		endemic
Cleridae	*Tarsostenus univittatus*	NE		
Cleridae	*Teloclerus compressicornis*	NE		
Cleridae	*Thanasimodes dorsalis*	VU	B2ab(ii,iii)	endemic

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Cleridae	*Thanasimus femoralis*	NE		
Cleridae	*Thanasimus formicarius*	NE		
Cleridae	*Tillodenops bimaculatus*	NE		
Cleridae	*Tilloidea laevigata*	DD		endemic
Cleridae	*Tilloidea unifasciata*	NE		
Cleridae	*Tillus elongatus*	NE		
Cleridae	*Tillus flabellicornis*	DD		endemic
Cleridae	*Tillus ibericus*	LC		endemic
Cleridae	*Tillus mozabitus*	DD		
Cleridae	*Wittmeridecus mediozonatus*	NE		
Cucujidae	*Cucujus cinnaberinus*	NE		
Cucujidae	*Cucujus haematodes*	NE		
Cucujidae	*Cucujus tulliae*	EN	B2ab(ii,iii)	endemic
Elateridae	*Ampedus adlbaueri*	DD		endemic
Elateridae	*Ampedus agilis*	DD		
Elateridae	*Ampedus assingi*	EN	B1ab(iii)+2ab(iii)	endemic
Elateridae	*Ampedus aurilegulus*	LC		
Elateridae	*Ampedus balteatus*	NE		
Elateridae	*Ampedus boquilobensis*	DD		endemic
Elateridae	*Ampedus brunnicornis*	NE		
Elateridae	*Ampedus camillae*	DD		endemic
Elateridae	*Ampedus canaliculatus*	DD		endemic
Elateridae	*Ampedus cardinalis*	NE		
Elateridae	*Ampedus cinnaberinus*	NE		
Elateridae	*Ampedus coenobita*	NT	B2b(iii)	
Elateridae	*Ampedus corsicus*	VU	D2	endemic
Elateridae	*Ampedus cretensis*	DD		endemic
Elateridae	*Ampedus elegantulus*	NE		
Elateridae	*Ampedus erythrogonus*	NE		
Elateridae	*Ampedus forticornis*	NE		
Elateridae	*Ampedus fuentei*	DD		endemic
Elateridae	*Ampedus gallicus*	DD		
Elateridae	*Ampedus glycereus*	NE		
Elateridae	*Ampedus hispanicus*	DD		endemic
Elateridae	*Ampedus hjorti*	NE		
Elateridae	*Ampedus karneri*	DD		endemic
Elateridae	*Ampedus koschwitzi*	DD		endemic
Elateridae	*Ampedus lubricus*	DD		endemic
Elateridae	*Ampedus macedonicus*	DD		endemic
Elateridae	*Ampedus magistrettii*	DD		endemic
Elateridae	*Ampedus maroccanus*	DD		endemic
Elateridae	*Ampedus melanurus*	NE		
Elateridae	*Ampedus melonii*	NT	B1b(iii)+2b(iii)	endemic
Elateridae	*Ampedus meybohmi*	DD		endemic
Elateridae	*Ampedus minos*	DD		endemic

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Elateridae	*Ampedus nemoralis*	NE		
Elateridae	*Ampedus nigerrimus*	NE		
Elateridae	*Ampedus nigrinus*	NE		
Elateridae	*Ampedus nigroflavus*	NE		
Elateridae	*Ampedus ochropterus*	NE		
Elateridae	*Ampedus ottomerkli*	LC		endemic
Elateridae	*Ampedus phoenicius*	DD		endemic
Elateridae	*Ampedus platiai*	NE		
Elateridae	*Ampedus pomonae*	NE		
Elateridae	*Ampedus pomorum*	NE		
Elateridae	*Ampedus pooti*	DD		endemic
Elateridae	*Ampedus praeustus*	NE		
Elateridae	*Ampedus pulcher*	NT	B1b(iii)	endemic
Elateridae	*Ampedus punctatus*	DD		
Elateridae	*Ampedus pyrenaeus*	DD		endemic
Elateridae	*Ampedus quadrisignatus*	NE		
Elateridae	*Ampedus quercicola*	NE		
Elateridae	*Ampedus rifensis*	EN	B1ab(iii)+2ab(iii)	endemic
Elateridae	*Ampedus rufipennis*	NE		
Elateridae	*Ampedus samai*	LC		endemic
Elateridae	*Ampedus sanguineus*	NE		
Elateridae	*Ampedus sanguinolentus*	NE		
Elateridae	*Ampedus schoettlei*	DD		endemic
Elateridae	*Ampedus scrofa*	NE		
Elateridae	*Ampedus sinuatus*	NT		
Elateridae	*Ampedus talamellii*	LC		endemic
Elateridae	*Ampedus tingitanus*	DD		endemic
Elateridae	*Ampedus triangulum*	NE		
Elateridae	*Ampedus turcicus*	NE		
Elateridae	*Ampedus vignai*	DD		endemic
Elateridae	*Brachygonus bouyoni*	NT	B2b(iii)	
Elateridae	*Brachygonus campadellii*	LC		
Elateridae	*Brachygonus dubius*	NE		
Elateridae	*Brachygonus frater*	DD		endemic
Elateridae	*Brachygonus gratiosus*	DD		endemic
Elateridae	*Brachygonus gunnurae*	DD		endemic
Elateridae	*Brachygonus hadullanus*	DD		endemic
Elateridae	*Brachygonus megerlei*	NE		
Elateridae	*Brachygonus meraculus*	NT		endemic
Elateridae	*Brachygonus ruficeps*	NE		
Elateridae	*Brachygonus ruficepsoides*	DD		endemic
Elateridae	*Calais parreysii*	NT		
Elateridae	*Calambus bipustulatus*	NE		
Elateridae	*Cardiophorus anticus*	LC		
Elateridae	*Cardiophorus gramineus*	NE		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Elateridae	*Cardiophorus kindermanni*	LC		
Elateridae	*Cardiophorus ruficollis*	NE		
Elateridae	*Cardiophorus sacratus*	NE		
Elateridae	*Crepidophorus mutilatus*	NE		
Elateridae	*Drapetes mordelloides*	NE		
Elateridae	*Ectamenogonus montandoni*	EN	B2ab(ii,iii)	
Elateridae	*Elater asmodaius*	DD		endemic
Elateridae	*Elater ferrugineus*	NE		
Elateridae	*Elater tauricus*	DD		endemic
Elateridae	*Elater turcicus*	DD		
Elateridae	*Haterumelater fulvago*	LC		
Elateridae	*Haterumelater schembrii*	DD		endemic
Elateridae	*Ischnodes sanguinicollis*	NE		
Elateridae	*Lacon ammanensis*	DD		endemic
Elateridae	*Lacon candezei*	LC		endemic
Elateridae	*Lacon carmelensis*	DD		endemic
Elateridae	*Lacon delagrangei*	DD		endemic
Elateridae	*Lacon drusa*	DD		endemic
Elateridae	*Lacon freidbergi*	NE		
Elateridae	*Lacon gillerforsi*	DD		
Elateridae	*Lacon graecus*	DD		endemic
Elateridae	*Lacon kapleri*	DD		endemic
Elateridae	*Lacon ladae*	LC		
Elateridae	*Lacon lepidopterus*	NE		
Elateridae	*Lacon lithophilus*	DD		endemic
Elateridae	*Lacon modestus*	NE		
Elateridae	*Lacon punctatus*	LC		
Elateridae	*Lacon querceus*	NE		
Elateridae	*Lacon solai*	DD		endemic
Elateridae	*Lanelater judaicus*	DD		
Elateridae	*Lanelater notodonta*	NE		
Elateridae	*Lanelater wittmeri*	NE		
Elateridae	*Limoniscus elegans*	DD		
Elateridae	*Limoniscus violaceus*	NE		
Elateridae	*Megapenthes lugens*	NE		
Elateridae	*Megapenthes rutilipennis*	NE		
Elateridae	*Melanotus castanipes*	NE		
Elateridae	*Melanotus cuneiformis*	DD		endemic
Elateridae	*Melanotus sulcicollis*	LC		endemic
Elateridae	*Melanotus villosus*	NE		
Elateridae	*Pittonotus simoni*	DD		
Elateridae	*Pittonotus theseus*	LC		
Elateridae	*Podeonius acuticornis*	NE		
Elateridae	*Podeonius subcyaneus*	DD		endemic
Elateridae	*Procraerus bicolor*	DD		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Elateridae	*Procraerus cretensis*	DD		endemic
Elateridae	*Procraerus levantinus*	DD		endemic
Elateridae	*Procraerus tibialis*	NE		
Elateridae	*Stenagostus laufferi*	LC		endemic
Elateridae	*Stenagostus rhombeus*	NE		
Elateridae	*Stenagostus rufus*	NE		
Elateridae	*Stenagostus sardiniensis*	EN	B1ab(iii)+2ab(iii)	endemic
Elateridae	*Stenagostus zuercheri*	DD		endemic
Elateridae	*Tetrigus cyprius*	EN	B2ab(iii)	
Erotylidae	*Aulacochilus chevrolati*	LC		endemic
Erotylidae	*Aulacochilus violaceus*	DD		
Erotylidae	*Triplax akbesiana*	DD		endemic
Erotylidae	*Triplax andreinii*	DD		endemic
Erotylidae	*Triplax atripennis*	DD		endemic
Erotylidae	*Triplax bedeli*	DD		endemic
Erotylidae	*Triplax breviscutata*	DD		endemic
Erotylidae	*Triplax castanea*	EN	B2ab(iii)	endemic
Erotylidae	*Triplax cyanescens*	DD		endemic
Erotylidae	*Triplax emgei*	EN	B1ab(iii)+2ab(iii)	endemic
Erotylidae	*Triplax lacordairii*	LC		
Erotylidae	*Triplax lepida*	NE		
Erotylidae	*Triplax marseuli*	NT	B1b(iii)	
Erotylidae	*Triplax melanocephala*	NT	B1b(iii)	
Erotylidae	*Triplax paganetti*	DD		endemic
Erotylidae	*Triplax rudis*	DD		endemic
Erotylidae	*Triplax russica*	NE		
Erotylidae	*Triplax subcylindrica*	DD		endemic
Erotylidae	*Triplax tergestana*	NE		
Eucnemidae	*Anelastidius feisthameli*	LC		
Eucnemidae	*Clypeorhagus clypeatus*	NE		
Eucnemidae	*Dirrhagofarsus attenuatus*	NE		
Eucnemidae	*Dromaeolus barnabita*	NE		
Eucnemidae	*Epiphanis cornutus*	NE		
Eucnemidae	*Eucnemis capucina*	NE		
Eucnemidae	*Farsus dubius*	NT	B2b(iii)	
Eucnemidae	*Hylis cariniceps*	NE		
Eucnemidae	*Hylis foveicollis*	NE		
Eucnemidae	*Hylis matthiesseni*	NE		
Eucnemidae	*Hylis olexai*	NE		
Eucnemidae	*Hylis simonae*	NE		
Eucnemidae	*Isoriphis marmottani*	NE		
Eucnemidae	*Isoriphis melasoides*	NE		
Eucnemidae	*Isoriphis nigriceps*	NE		
Eucnemidae	*Melasis buprestoides*	NE		
Eucnemidae	*Melasis fermini*	VU	D2	endemic

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Eucnemidae	*Microrhagus emyi*	NE		
Eucnemidae	*Microrhagus hummleri*	DD		endemic
Eucnemidae	*Microrhagus lepidus*	NE		
Eucnemidae	*Microrhagus pygmaeus*	NE		
Eucnemidae	*Microrhagus pyrenaeus*	NE		
Eucnemidae	*Nematodes filum*	NE		
Eucnemidae	*Otho sphondyloides*	NE		
Eucnemidae	*Rhacopus sahlbergi*	NE		
Eucnemidae	*Xylophilus corticalis*	NE		
Lucanidae	*Aesalus scarabaeoides*	NE		
Lucanidae	*Ceruchus chrysomelinus*	NE		
Lucanidae	*Dorcus alexisi*	EN	B1ab(iii)	endemic
Lucanidae	*Dorcus musimon*	VU	B2ab(iii)	endemic
Lucanidae	*Dorcus parallelipipedus*	NE		
Lucanidae	*Dorcus peyronis*	EN	B2ab(iii)	
Lucanidae	*Lucanus barbarossa*	LC		
Lucanidae	*Lucanus busignyi*	VU	D2	endemic
Lucanidae	*Lucanus cervus*	LC		
Lucanidae	*Lucanus laticornis*	NT	B1b(iii)	
Lucanidae	*Lucanus macrophyllus*	DD		
Lucanidae	*Lucanus pontbrianti*	DD		
Lucanidae	*Lucanus tetraodon*	LC		
Lucanidae	*Platycerus caprea*	NE		
Lucanidae	*Platycerus caraboides*	NE		
Lucanidae	*Platycerus delagrangei*	DD		endemic
Lucanidae	*Platycerus senguni*	DD		endemic
Lucanidae	*Platycerus spinifer*	LC		
Lucanidae	*Sinodendron cylindricum*	NE		
Mycetophagidae	*Esarcus abeillei*	NT		endemic
Mycetophagidae	*Esarcus baudii*	VU	D2	endemic
Mycetophagidae	*Esarcus besucheti*	DD		endemic
Mycetophagidae	*Esarcus fiorii*	VU	B2ab(iii)	endemic
Mycetophagidae	*Esarcus franzi*	VU	D2	endemic
Mycetophagidae	*Esarcus inexpectatus*	DD		endemic
Mycetophagidae	*Esarcus iolensis*	DD		endemic
Mycetophagidae	*Esarcus leprieuri*	NT	B2b(iii)	endemic
Mycetophagidae	*Esarcus letourneuxi*	DD		endemic
Mycetophagidae	*Esarcus martini*	DD		endemic
Mycetophagidae	*Litargus connexus*	NE		
Mycetophagidae	*Litargus leprieuri*	LC		endemic
Mycetophagidae	*Pseudotriphyllus vicarius*	DD		endemic
Mycetophagidae	*Triphyllus bicolor*	NE		
Rhysodidae	*Clinidium canaliculatum*	VU	B2ab(ii,iii)	endemic
Rhysodidae	*Omoglymmius germari*	NE		
Rhysodidae	*Rhysodes sulcatus*	NE		

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Scarabaeidae Cetoniinae	*Chromovalgus peyroni*	VU	B2ab(iii)	endemic
Scarabaeidae Cetoniinae	*Gnorimus baborensis*	EN	B1ab(iii)+2ab(iii)	endemic
Scarabaeidae Cetoniinae	*Gnorimus decempunctatus*	EN	B2ab(ii,iii)	endemic
Scarabaeidae Cetoniinae	*Gnorimus nobilis*	NE		
Scarabaeidae Cetoniinae	*Gnorimus variabilis*	NE		
Scarabaeidae Cetoniinae	*Osmoderma barnabita*	NE		
Scarabaeidae Cetoniinae	*Osmoderma brevipenne*	EN	B2ab(ii,iii)	
Scarabaeidae Cetoniinae	*Osmoderma cristinae*	EN	B1ab(i,ii,iii)+ 2ab(i,ii,iii)	endemic
Scarabaeidae Cetoniinae	*Osmoderma eremita*	NE		
Scarabaeidae Cetoniinae	*Osmoderma lassallei*	EN	B2ab(ii,iii)	
Scarabaeidae Cetoniinae	*Protaetia affinis*	LC		
Scarabaeidae Cetoniinae	*Protaetia mirifica*	VU	B2ab(ii,iii,iv)	
Scarabaeidae Cetoniinae	*Protaetia opaca*	LC		
Scarabaeidae Cetoniinae	*Protaetia sardea*	VU	B2ab(ii,iii)	endemic
Scarabaeidae Cetoniinae	*Protaetia speciosissima*	NE		
Scarabaeidae Cetoniinae	*Trichius fasciatus*	NE		
Scarabaeidae Cetoniinae	*Trichius sexualis*	NE		
Scarabaeidae Cetoniinae	*Trichius zonatus*	NE		
Scarabaeidae Cetoniinae	*Valgus hemipterus*	NE		
Scarabaeidae Dynastinae	*Calicnemis latreillii*	EN	B2ab(iii,v)	endemic
Scarabaeidae Dynastinae	*Calicnemis obesa*	EN	B2ab(iii,v)	
Scarabaeidae Dynastinae	*Calicnemis obesa ssp. sardiniensis*	EN	B1ab(i,ii,iii,v)+ 2ab(i,ii,iii,v)	endemic
Scarabaeidae Euchirini	*Propomacrus cypriacus**	CR	B2ab(iii)	endemic
Scarabaeidae Euchirini	*Propomacrus bimucronatus*	VU	B2ab(iii)	
Tetratomidae	*Tetratoma baudueri*	NT		
Tetratomidae	*Tetratoma crenicollis*	DD		endemic
Tetratomidae	*Tetratoma tedaldi*	VU	B2ab(iii)	endemic
Trogositidae	*Nemozoma breviatum*	DD		endemic
Trogositidae	*Nemozoma elongatum*	NE		
Trogositidae	*Nemozoma pliginskyi*	DD		
Trogositidae	*Seidlitzella procera*	NT	B2b(iii)	endemic
Trogositidae	*Temnochila caerulea*	LC		

* currently considered as a subspecies of *P. bimucronatus*

Taxonomic group	Species	IUCN Red List Category at the Mediterranean level	IUCN Red List Criteria	Mediterranean endemic
Trogositidae	*Tenebroides fuscus*	NE		
Trogositidae	*Tenebroides maroccanus*	DD		
Trogositidae	*Thymalus limbatus*	NE		
Trogositidae	*Thymalus punicus*	DD		endemic
Zopheridae	*Aulonium ruficorne*	LC		
Zopheridae	*Aulonium trisulcum*	NE		
Zopheridae	*Bitoma crenata*	NE		
Zopheridae	*Bitoma turcica*	DD		endemic
Zopheridae	*Colobicus hirtus*	NE		
Zopheridae	*Colydium elongatum*	NE		
Zopheridae	*Colydium filiforme*	NE		
Zopheridae	*Corticus celtis*	LC		
Zopheridae	*Coxelus alinae*	DD		endemic
Zopheridae	*Coxelus bituberculatus*	DD		
Zopheridae	*Coxelus humeridens*	DD		endemic
Zopheridae	*Coxelus pictus*	NE		
Zopheridae	*Diodesma besucheti*	EN	B1ab(iii)+2ab(iii)	endemic
Zopheridae	*Diodesma denticincta*	NT	B1a(i)	endemic
Zopheridae	*Diodesma parallela*	DD		endemic
Zopheridae	*Diodesma subterranea*	NE		
Zopheridae	*Diplagia hellenica*	DD		endemic
Zopheridae	*Endophloeus exculptus*	NE		
Zopheridae	*Endophloeus markovichianus*	LC		
Zopheridae	*Microprius rufulus*	LC		
Zopheridae	*Nosodomodes diabolicus*	LC		
Zopheridae	*Nosodomodes rotundicollis*	DD		endemic
Zopheridae	*Nosodomodes syriacus*	VU	B1ab(iii)	endemic
Zopheridae	*Pycnomerus italicus*	EN	B1ab(iii)+2ab(iii)	endemic
Zopheridae	*Pycnomerus sulcicollis*	NE		
Zopheridae	*Pycnomerus terebrans*	NE		
Zopheridae	*Rhopalocerus rondanii*	NE		
Zopheridae	*Synchita fallax*	LC		
Zopheridae	*Synchita humeralis*	NE		
Zopheridae	*Synchita mediolanensis*	LC		
Zopheridae	*Synchita separanda*	LC		
Zopheridae	*Synchita undata*	LC		
Zopheridae	*Synchita variegata*	LC		
Zopheridae	*Tarphius besucheti*	EN	B2ab(ii,iii)	endemic
Zopheridae	*Tarphius fairmairei*	DD		endemic
Zopheridae	*Tarphius gibbulus*	NT	B2a(i,ii)b(iii)	endemic
Zopheridae	*Tarphius isabelae*	DD		endemic
Zopheridae	*Tarphius liliputanus*	DD		endemic
Zopheridae	*Tarphius maroccanus*	DD		endemic
Zopheridae	*Tarphius oulmesensis*	VU	D2	endemic
Zopheridae	*Xylolaemus fasciculosus*	EN	B2ab(ii,iii)	

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