European Red List of Dragonflies

Compiled by Vincent J. Kalkman, Jean-Pierre Boudot, Rafał Bernard, Klaus-Jürgen Conze, Geert De Knijf, Elena Dyatlova, Sónia Ferreira, Miloš Jović, Jürgen Ott, Elisa Riservato and Göran Sahlén

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Table of contents

Foreword iv

Acknowledgements v

Executive summary vii

1. Background 1
1.1 An introduction to damselflies and dragonflies 1
1.2 The European context 2
1.3 IUCN Red List Categories 3
1.4 Objectives of the assessment 4

2. Assessment methodology 5
2.1 Global and regional assessments 5
2.2 Geographic scope 5
2.3 Taxonomic scope 5
2.4 Preliminary assessments 6
2.5 Review workshop and evaluation of the assessments 6

3. Results and discussion 7
3.1 Diversity of dragonflies in Europe 7
3.2 Endemic species richness 8
3.3 Threatened dragonflies 9
3.4 Major threats to dragonflies in Europe 12

4. Conservation priorities 13
4.1 General 13
4.2 Legislation 13
4.3 Regional actions 13
4.4 Dragonflies as tools: databases and monitoring 17

5. Conclusion and recommendations 18

References 19

Appendix 1. Red List status of European dragonflies 20

Appendix 2. Number of dragonfly species recorded in the 27 EU member states 23

Appendix 3. Example species summary and distribution map 24

Foreword

Europe is a continent rich in natural and cultural heritage, with a diverse range of habitat conditions from dry Mediterranean maquis in the south to the Arctic tundra of the far north. Possibly more than anywhere else in the world the European landscapes have been changed by human activities so that now the continent is covered with a mosaic of natural and semi-natural habitats surrounding urbanized areas. Although bringing higher diversity, this modification has obviously also placed great pressures on our wildlife and natural areas.

In 2001, EU Member States made the commitment to halt the loss of biodiversity within the EU by 2010. The EU Biodiversity Action Plan, adopted in 2006, sets out the main targets and activities needed to achieve this commitment. The Mid Term Review of the implementation of the Biodiversity Action Plan published by the Commission in December 2008 demonstrates that, despite some progress made, it is highly unlikely that the 2010 target will be met. Numerous scientific studies show that biodiversity in Europe has been declining rapidly for some time during periods of expansion and intensification of land use. The recent extensive reporting process under Article 17 of the EU Habitats Directive underlines this fact as most species and habitats protected under the Habitats Directive are still not under a favourable conservation status.

Red Lists are another important tool to scientifically assess and communicate the status of species. They usefully complement the reporting under the Habitats Directive as they address all species in a specific taxonomic group, not just those protected by the EU nature legislation. They hence give important complementary information about the situation of biodiversity in Europe. This is the first assessment of the Red List status of Europe's dragonflies and damselflies. It has evaluated 137 species and subspecies present in Europe. The assessment has followed the Red List methodology developed by the International Union for Conservation of Nature (IUCN), which is the most common methodology used throughout the world.

This study shows us that about 15% of European dragonflies are threatened. This compares with 9% of butterflies, 11% of saproxylic beetles, 13% of birds, 15% of mammals, 19% of reptiles, and 23% of amphibians, the other groups that have been assessed in Europe. More than a quarter of the assessed dragonflies still have decling populations. The loss and decline of their habitat poses the main threat, as freshwater ecosystems are facing high pressures, due to the increased water demand for agriculture and domestic use and to the impact of climate change.

What can we as Europeans do about this? First and foremost, we need to fully implement the existing European legislation. The EU Habitats and Birds Directives are the main pieces of legislation ensuring the protection of Europe's nature. The Natura 2000 network of protected sites and the efforts to conserve and restore biodiversity in the wider countryside are helping to guarantee its future conservation and sustainable use. Improved water management and decreasing pollution have had a positive impact on a number of species. However, additional efforts are required to conserve dragonflies fauna, especially in southern Europe, where freshwater management plans need to be further developed, taking into consideration species requirements.

I hope that this European Red List for dragonflies will add another piece of evidence for the fact that efforts aimed at halting the loss of biodiversity and the implementation of related European legislation need a major boost in the coming years.

Ladislav Miko
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Acknowledgements

All IUCN's Red Listing processes rely on the willingness of scientists to pool their collective knowledge in order to make reliable status assessments. Without their enthusiastic commitment to species conservation, this kind of regional overview would not be possible.

Coordinators of the European Red List of Dragonflies were Helen Temple, Annabelle Cuttelod (IUCN Species Programme) and Vincent Kalkman (European Invertebrate Survey, the Netherlands). Jean-Christophe Vié provided guidance, encouragement, and good advice throughout the project. Ana Nieto, Teresa Oliveros Martinez, Anna Rosenberg and Hugo Ruiz Lozano provided substantial assistance with financial management of the project. Susannah Ohanlon, Vineet Katariya, Jim Ragle and Melanie Bilz provided high-quality support on GIS and database issues. Sonia Ferreira and Vincent Kalkman organized the evaluation workshop. Workshop facilitators were Ana Nieto and Melanie Bilz. Anna Lejfelt-Sahlén and Laurel Bennett corrected and improved the English.

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Participants at the evaluation workshop, Faro (Portugal), April 2009. Photo © Sabine Conze

The Moorland Hawker *Aeshna juncea* is common and widespread in most of northern and central Europe. In the south of its range, it might, however, decline due to climate change. Photo © Jean-Pierre Boudot

Executive summary

Aim

The European Red List is a review of the conservation status of ca. 6,000 European species (dragonflies, butterflies, freshwater fishes, reptiles, amphibians, mammals and selected groups of beetles, molluscs, and vascular plants) according to the IUCN regional Red Listing guidelines. It identifies species that are threatened by extinction at the regional level – so that appropriate conservation action can be taken to improve their status. This Red List publication summarises the results concerning the European dragonflies.

Scope

All dragonfly species native to Europe are included, except those confined to northern Caucasus. The geographic scope is continent-wide, extending from Iceland in the west to the Urals in the east, and from Franz Josef Land in the north to the Mediterranean and the Canary Islands in the south. The Caucasian region is not included. Red List assessments were made at two regional levels: for geographical Europe, and for the 27 current Member States of the European Union.

Status assessment

The status of all species was assessed using the IUCN Red List Criteria (IUCN 2001). This is the world's most widely accepted system for measuring extinction risk. All assessments followed the Guidelines for Application of IUCN Red List Criteria at Regional Levels (IUCN 2003). Preliminary regional assessments were made by Jean-Pierre Boudot and Vincent Kalkman. These assessments were then evaluated by Rafał Bernard, Klaus-Jürgen Conze, Geert De Knijf, Elena Dyatlova, Sónia Ferreira, Miloš Jović, Jürgen Ott, Elisa Riservato and Göran Sahlén during a workshop held in Faro, Portugal and through correspondence with relevant experts.

The assessments are available on the European Red List website and internet platform: http://ec.europa.eu/environment/nature/conservation/species/redlist and http://www.iucnredlist.org/europe.

Dragonflies in Europe

Dragonflies are colourful, relatively large, and well-known insects. Their larvae live in freshwater habitats such as lakes, bogs, seepages, rivers and springs. Dragonflies occur almost everywhere in Europe, but the highest species diversity is found in the southern half, with the highest numbers in parts of southern France, the footland of the Alps and parts of the Balkan Peninsula.

Europe holds 138 species, only three of which are not found in the 27 member states of the EU. Five species were regarded as Not Applicable, as they have no stable populations in Europe. Two species (*Cordulegaster helladica* and *Onychogomphus forcipatus*) have three subspecies each, the taxonomy and distribution of which are sufficiently well-known to make them eligible for an assessment. Thus, a total of 137 species and subspecies were assessed.

Eighteen of the European species are endemic to Europe (i.e. they are not found anywhere else in the world). Fourteen are endemic to the EU27. Sixteen of the 18 endemics are either confined to islands, to the Balkan Peninsula or (at least mainly) to the Iberian Peninsula and France.

Results

Approximately one out of seven (15%) European dragonflies are threatened in Europe, with a similar proportion being threatened at the EU level. An additional 11% are considered Near Threatened. By comparison, 23% of the amphibians, 19% of the reptiles, 15% of the mammals, 13% of the birds, 11% of the saproxylic beetles and 9% of the butterflies in Europe are threatened (Temple & Cox 2009, Cox & Temple 2009, Temple & Terry 2007, BirdLife International 2004, Nieto & Alexander 2010, Van Swaay *et al.* 2010). No other groups have so far been comprehensively assessed at the European level. About a quarter (24%) of the European dragonflies have declining populations, ten percent are increasing and roughly half of the species are stable. For the remaining 12%, the available information is too limited to define any population trends.

Most of the threatened species are confined to parts of southern Europe. Currently, the main threat to European dragonflies is desiccation of their habitats due to the increasingly hot and dry summers combined with intensified water extraction for drinking and irrigation. Other important threats to species living in running waters are water pollution and the construction of dams and reservoirs.

Conclusion and recommendations

This report shows where the highest levels of diversity and endemism, and the greatest proportion of threatened dragonflies are found within the European region. Using these parameters, three key areas for dragonfly conservation in Europe have become evident: the southern Balkan Peninsula, Crete and the Iberian Peninsula. Certain measures are urgent:

- A freshwater action plan is needed for Crete.
- Species action plans should be made for the most threatened species on the southern Balkan Peninsula, especially for *Pyrrhosoma elisabethae*, *Cordulegaster helladica* ssps. and *Somatochlora borisi*, as these taxa are endemic to Europe.
- Large scale and multi-taxa conservation plans for river systems are needed in order to establish a balance between agriculture, development and nature conservation, especially on the Iberian Peninsula, in southern France, Greece and parts of Italy.
- Better management practices for fish ponds and rice fields would also have valuable conservation effects without increasing the long term costs.
- Development of a sustainable network of local experts and volunteers is needed to facilitate the conservation and monitoring of dragonfly species and habitats.

1. Background

1.1 An introduction to damselflies and dragonflies

Dragonflies are well-known insects, and many people appreciate their striking colours and equilibristic flight. Their larvae live in running and standing freshwater environments. Some species are tolerant of brackish and salty waters. Many species have small ranges, and are specific to certain habitats such as alpine mountain bogs or desert wadis. In the temperate regions of the world, dragonflies are frequently used as indicators of environmental health. Their sensitivity to habitat quality (e.g. forest cover, water chemistry, rivers and bank structure), their amphibious life cycle, and the relative ease of their identification make dragonflies well suited for evaluating environmental changes both in the long term (biogeography, climatology) and in the short term (biology conservation, water pollution, structural alteration of running and standing waters). Dragonfly identification keys are available in most countries, and a field guide covering almost all European dragonfly species was recently published (Dijkstra & Lewington 2006). This makes it possible for volunteers to conduct mapping schemes, which produce distributional data that may be used in management plans.

Dragonflies are recognized by their long and slender abdomen, their large globular eyes, which often make up a large portion of the head, their short antennae and their long wings. They are divided into two suborders, namely Zygoptera or damselflies, and Anisoptera or true dragonflies. In this report the word 'dragonflies' is used for both suborders.

Dragonfly larvae prey on all kinds of small animals up to the size of tadpoles and small fish. They take from a few weeks to several years to develop. Emergence takes place above the water on plants or on the shore, after which most species leave the water edge to mature. The males return to the water to search for females or to establish territories, whereas the females often return only to mate and to lay their eggs.

Blue hawker *Aeshna cyanea* (Least Concern) in flight. All dragonflies catch prey such as mosquitoes in flight. Photo © Jean-Pierre Boudot.

With about 5,680 species, the dragonflies constitute a relatively small insects order (Kalkman *et al.* 2008), and most species are found in the tropics. A recent study showed that in a global assessment about 10% of the world's dragonflies would probably be regarded as Threatened (CR, EN or VU) and 35% as Data Deficient (Clausnitzer *et al.* 2009). A total of 138 dragonfly species are present in Europe (Table 1), 48 of which belong to the damselflies and 90 to the 'true' dragonflies. Five of

Dainty Bluet *Coenagrion scitulum* (Least Concern) (left) and the Azure hawker *Aeshna caerulea* (Least Concern) (right). The two suborders of Odonata, damselflies and dragonflies, are easy to recognize. In damselflies the fore- and hindwing have the same shape, the eyes are widely separated and most species keep their wings shut when at rest. In dragonflies the hindwing is much broader than the forewing, the eyes touch each other in most species and the wings are spread out when at rest. Photos © Jean-Pierre Boudot.

Table 1. Diversity and endemism of European dragonflies. This table also includes the five species which were not assessed due to their marginal occurrence in Europe.

Order	Suborder	Family	Europe		EU 27	
			Number of species (number of species and subspecies)	Number of endemic (sub)species (% endemic)	Number of species (number of species and subspecies)	Number of endemic (sub)species (% endemic)
Odonata	Zygoptera	Calopterygidae	4	1 (25)	4	1 (25)
		Epallagidae	1	0	1	0
		Lestidae	9	0	9	0
		Coenagrionidae	30	3 (10)	28	2 (7)
		Platycnemididae	4	2 (50)	4	2 (50)
	Anisoptera	Aeshnidae	20	1 (5)	20	1 (5)
		Gomphidae	13 (15)	2 (13)	13 (15)	2 (13)
		Cordulegastridae	7 (9)	6 (66)	7 (9)	4 (44)
		Macromiidae	1	1 (100)	1	1 (100)
		Corduliidae	11	1 (9)	10	0
		Libellulidae	38	1 (3)	38	1 (3)
Total			**138 (142)**	**18**	**135 (139)**	**14**

the species occur in Europe, but have no stable European populations. They have been regarded as Not Applicable, and have consequently not been assessed. A total of 11 families occur in the region; the largest ones being the Libellulidae (38 species) followed by the Coenagrionidae (30 species), the Aeshnidae (20 species) and the Gomphidae (13 species). Two species (*Cordulegaster helladica* and *Onychogomphus forcipatus*) have three subspecies each, the taxonomy and distribution of which are sufficiently well-known to make them eligible for an assessment. Thus, a total 137 species and subspecies were assessed. Eighteen of these are endemic to the region, endemism being especially common within the families Calopterygidae, Platycnemididae and Cordulegastridae (Table 1).

1.2 The European context

Europe is one of the seven traditional continents of the Earth, although physically and geologically it is the westernmost peninsula of Eurasia. Europe is bound to the north by the Arctic Ocean, to the west by the Atlantic Ocean, to the south by the Mediterranean Sea, and to the southeast by the Black Sea and the Caucasian mountains. To the east, Europe is separated from Asia by the Ural Mountains and by the Caspian Sea (Figure 2). Europe is the world's second-smallest continent in terms of area, covering approximately 10,400,000 square kilometres (4,010,000 square miles) or 2% of the Earth's surface. In terms of human population, it is the third-largest continent (after Asia and Africa) with a population of some 731 million people – about 11% of the world's population. Europe is the most urbanised and, together with Asia, the most densely populated continent in the world.

The European Union, comprising 27 Member States, is Europe's largest political and economical entity, and the world's largest economy. The per-capita GDP of many EU states is extremely high by international standards, and the rates of resource consumption and waste production are correspondingly high – the "ecological footprint" of the EU 27 has been estimated to exceed the region's biological capacity (the total area of cropland, pasture, forest, and fishing grounds available to produce food, fibre and timber, and absorb waste) by 2.6 times (WWF 2007).

The EU area extends from the Arctic Circle in the north to the Mediterranean in the south, and from the Atlantic coast in the west to coast of the Black Sea in the east – an area containing a great diversity of landscapes and habitats, and a very rich flora and fauna. European biodiversity includes 488 species of birds (IUCN 2009), 260 species of mammals (Temple & Terry 2007, 2009), 151 species of reptiles, 85 species of amphibians, 546 species of freshwater fishes (Kottelat & Freyhof 2007), 20-25,000 species of vascular plants and well over 100,000 species

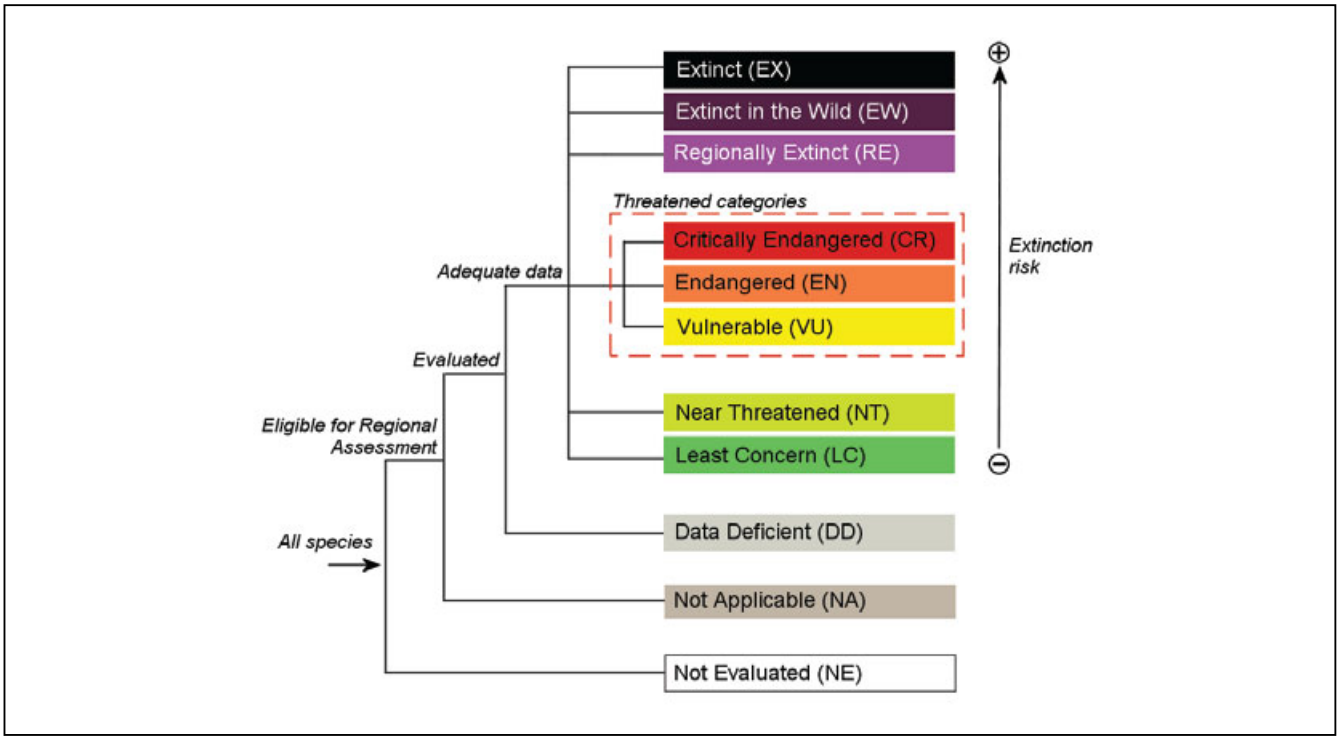
of invertebrates (Fauna Europaea 2004). Mediterranean Europe is particularly rich in plant and animal species, and has been recognised as a global "biodiversity hotspot" (Mittermeier *et al.* 2004, Cuttelod *et al.* 2008).

Europe has arguably the most highly fragmented landscape of all continents, and only a tiny fraction of its land surface can be considered as wilderness. For centuries most of Europe's land has been used by humans to produce food, timber fuel and living space, and currently more than 80% of the land in Western Europe is under some form of direct management. Consequently, the European species are to a large extent dependent upon semi-natural habitats created and maintained by human activity; particularly traditional, non-intensive forms of land management. These habitats are under pressure from agricultural intensification, urban sprawl, infrastructure development, land abandonment, acidification, eutrophication and desertification. Many species are directly affected by overexploitation, persecution and the impact of alien invasive species. Climate change is also set to become an increasingly serious threat in the future. Europe is a huge, diverse region, and the relative importance of different threats varies widely across its biogeographic regions and countries. Although considerable efforts have been made to preserve European habitats and species biodiversity in Europe declines, and the associated loss of vital ecosystem services (such as water purification, crop pollination, and carbon sequestration) continues to be a major concern in the region.

1.3 IUCN Red List Categories

The conservation status of plants and animals is one of the most widely used indicators for assessing the condition of ecosystems and their biodiversity. It also provides an important tool in establishing priorities for species conservation. At the global scale, the best source of information on the conservation status of plants and animals is the *IUCN Red List of Threatened Species* (www.iucnredlist.org; IUCN 2009). The Red List provides information about the taxonomic status conservation status and distribution of the taxa that have been evaluated using the *IUCN Red List Categories and Criteria: Version 3.1* (IUCN 2001). This system is designed to determine the relative risk of extinction, with the main purpose of cataloguing and highlighting taxa that face an increased risk of extinction. The IUCN Red List Categories are based on a set of quantitative criteria linked to population trends, population size and structure, and geographic range. Species classified as Vulnerable, Endangered and Critically Endangered are regarded as 'threatened'. When conducting regional or national assessments, two additional categories are used: Regionally Extinct and, in the case of species that are non-indigenous or have only a marginal occurrence within the area, Not Applicable (IUCN 2003) (Figure 1).

Figure 1. IUCN Red List Categories at regional scale



1.4 Objectives of the assessment

The European regional assessment has four main objectives:

- To contribute to regional conservation planning by providing a baseline dataset concerning the status of European dragonflies.
- To identify geographic areas and habitats in need of conservation measures, and to ensure that all European dragonflies reach and maintain a favourable conservation status.
- To identify the major threats and to propose measures to address them.
- To strengthen the network of experts focused on the conservation of dragonflies in Europe, so that the assessment information can be kept updated, and expertise can be targeted to address the highest conservation priorities.

The assessment provides two main results:

- This summary report with information on the status and distribution of European dragonflies, the main threats to them, and recommendations concerning conservation measures;
- Website and data platforms showcasing the data in the form of species fact sheets for all European dragonflies, along with background and other interpretative material: http://ec.europa.eu/environment/nature/conservation/species/redlist and http://www.iucnredlist.org/europe.

The data presented in this report provides a snapshot based on the knowledge available at the time of writing. The database will be continuously updated and made freely and widely available. IUCN will ensure wide dissemination of the data to relevant decision makers, NGOs and scientists to promote and support the implementation of practical conservation measures.

2. Assessment methodology

2.1 Global and regional assessments

The extinction risk of a species can be assessed at a global, regional or national level. A species may be assigned to another category in the Global Red List than in a Regional Red List. For example, a species that is common worldwide and classed as Least Concern (LC) in the Global Red List could face a sufficiently high level of threat to qualify for the Endangered category (EN) in a particular region (see Figure 1 for the explanation of the IUCN categories). In order to avoid an over- or underestimation of the regional extinction risk, the Guidelines for the application of IUCN Red List Criteria at Regional Level should be applied (IUCN 2003). Logically, an endemic species should be assigned to the same category at the regional and global levels, as it is not present in any other part of the world.

2.2 Geographic scope

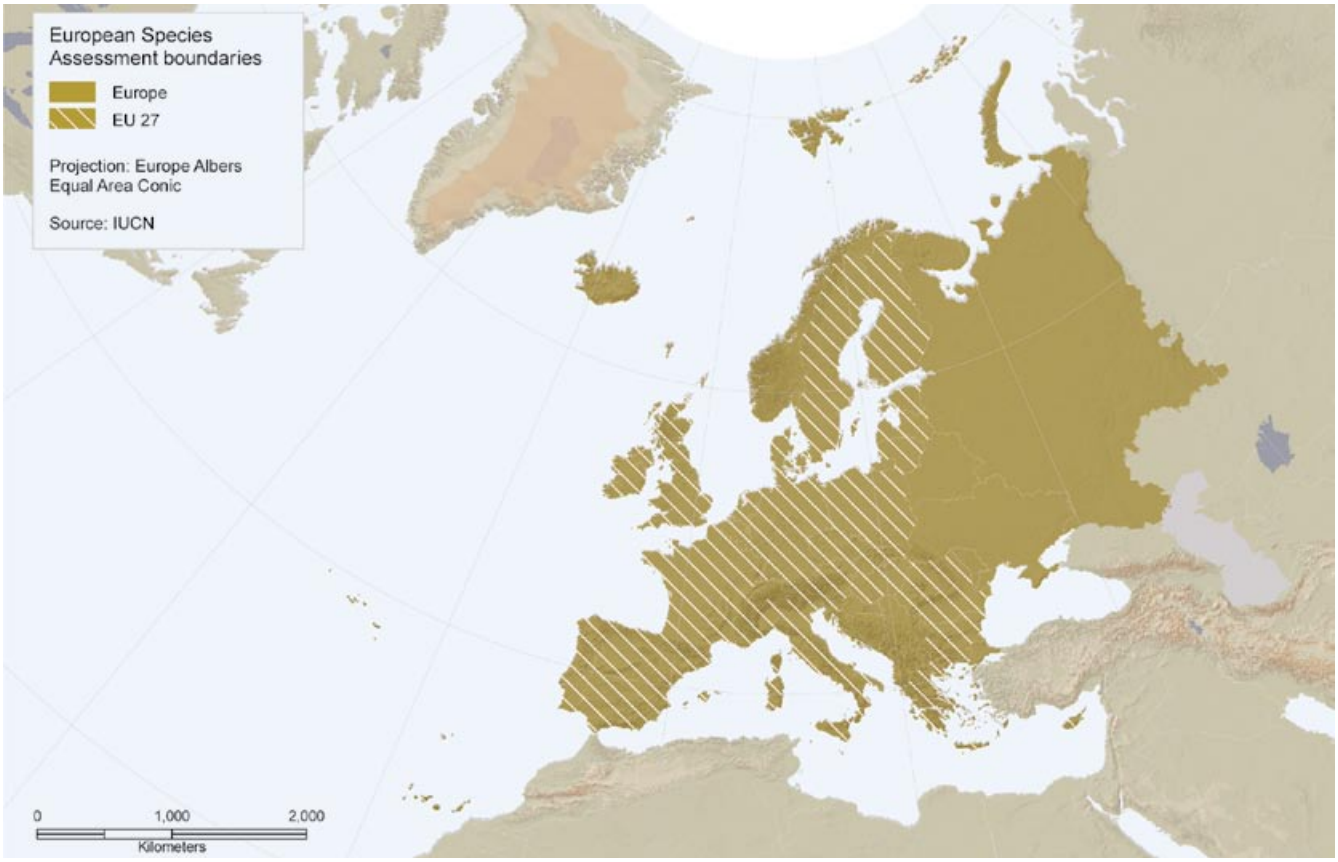
The geographical scope is continent-wide, extending from Iceland in the west to the Urals in the east (including the European parts of the Russian Federation), and from Franz Josef's Land in the north to the Mediterranean in the south (Figure 2). The Canary Islands, Madeira and the Azores are also included. The Caucasus region, in the south-eastern corner of Europe, is excluded from the assessments, and is not considered to be part of Europe in this context.

Red List assessments were made at two regional levels: 1) for geographical Europe (limits described above); and 2) for the area of the 27 Member States of the European Union (EU27).

2.3 Taxonomic scope

All dragonfly species native to Europe were included in the assessment. Five species with marginal occurrences in Europe were classed as Not Applicable, and were therefore not assessed (*Anax junius*, *Pantala flavescens*, *Platycnemis subdilatata, Trithemis arteriosa*, *Trithemis kirbyi*). The taxonomy largely follows the Global Species Database Odonata (Van Tol 2006) available at: http://www.odonata.info, albeit with minor deviations. Subspecies were not assessed, with the exception of those of *Onychogomphus forcipatus* and *Cordulegaster helladica*.

Figure 2. Regional assessments were made for two areas – geographical Europe and the EU 27



The second European record of the Orange-winged Dropwing *Trithemis kirbyi* was made in 2008. It was classed as Not Applicable, and therefore not assessed although it is likely that it will establish itself in Europe in the future as a result of climate change. Photo © Jean-Pierre Boudot.

2.4 Preliminary assessments

Preliminary assessments of all European dragonfly species were conducted by Jean-Pierre Boudot and Vincent Kalkman, using existing literature, data sources and personal knowledge. For each taxon the following data were entered into the Species Information Service (SIS) database:

- Taxonomic classification
- Geographic range (including a distribution map)
- Red List Category and Criteria
- Population information
- Habitat preferences
- Major threats
- Conservation measures
- Other general information
- Key literature references

2.5 Review workshop and evaluation of assessments.

Eleven experts of European dragonflies were invited to attend a five-day regional review workshop, held in Faro (Portugal) in April 2008. The invited specialists (Rafał Bernard, Jean-Pierre Boudot, Klaus-Jürgen Conze, Geert De Knijf, Elena Dyatlova, Sónia Ferreira, Miloš Jović, Vincent Kalkman, Jürgen Ott, Elisa Riservato and Göran Sahlén) were selected so that knowledge of all parts of Europe was available during the workshop. Preliminary species summary reports were distributed to all the participants before the review workshop, so that they could check the presented data and prepare any suggested alterations that they would like to discuss at the workshop. The preliminary assessments were reviewed during the workshop, and new information was added to the species summaries and maps. Red List Categories were then defined for each species at the European and EU 27 levels.

Following the review workshop, the data was edited, and unresolved questions were settled through communications with the workshop participants. Consistency in the use of the IUCN Criteria was checked by IUCN staff from the IUCN Red List Unit and the IUCN/SSC Dragonfly Specialist Group. The resulting finalised IUCN Red List assessments are a product of scientific consensus concerning the status of the species backed by relevant literature and data sources.

Reviewing species assessments at the European Dragonflies workshop in Faro (Portugal). Photo © Melanie Bilz.

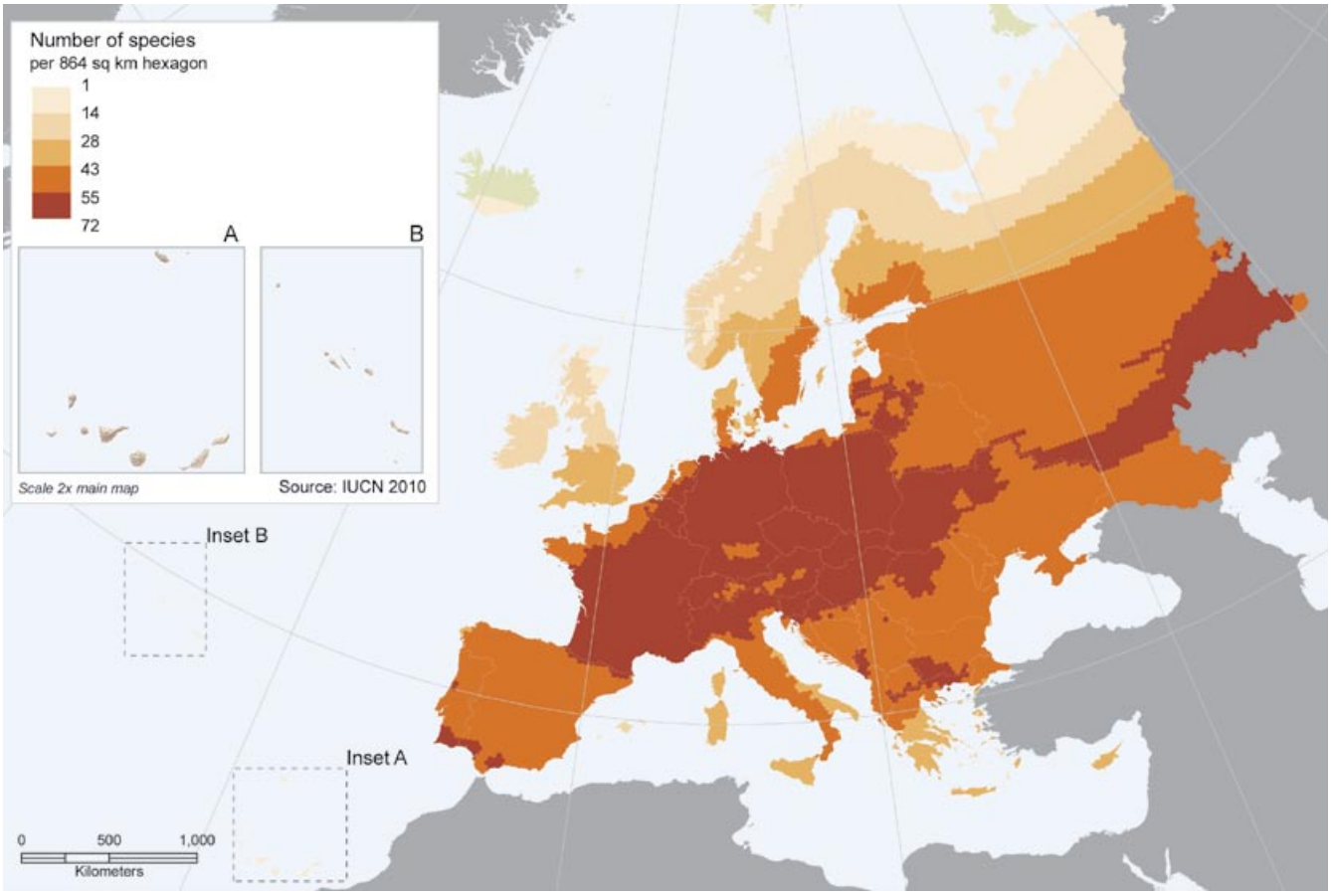
3. Results and Discussion

3.1 Diversity of dragonflies in Europe

One hundred and thirty-seven (sub)species of dragonflies have been assessed for Europe, 134 of which also occur in the EU 27 (section 1.1). Five additional species (*Anax junius*, *Platycnemis subdilatata*, *Pantala flavescens*, *Trithemis arteriosa*, *Trithemis kirbyi*) have been recorded in Europe but were not assessed because they do not maintain stable populations in Europe. Figure 3 shows the distribution of dragonfly diversity in Europe, and Appendix 2 gives the number of species per country. The pattern of diversity can roughly be attributed to temperature and precipitation. From north to south the diversity increases with increasing temperature. It tends to decrease in dryer regions, where the diversity of freshwater habitats is reduced. Examples of such areas include part of the Iberian Peninsula, Italy and the Balkan Peninsula. As a consequence, the highest diversity in Europe is found in the southern part of Central Europe; certain areas in southern France, the footland of the Alps and certain parts of the Balkan Peninsula. In these areas, Mediterranean species co-occur with species from more temperate climates.

Since the 1990s, many southern species are showing a considerable northwards expansion of their range, some of them increasing their range by hundreds of kilometres in a period of less than twenty years. This expansion is largely related to the higher summer temperatures, although it is facilitated by the multiplication of man-made water bodies in some regions. Higher summer temperatures are, however, also likely to have a negative impact on some of the southern regions, causing extinction of northern and mountain species, increasingly arid conditions, and thereby a lower diversity of dragonflies. If this comes true, then the diversity patterns of dragonflies in Europe are likely to show a northwards shift.

Figure 3. Species richness of European dragonflies



The Broad Scarlet *Crocothemis erythraea* (Least Concern) is one of the best examples of species expanding their range due to climate change. Photo © Jean-Pierre Boudot.

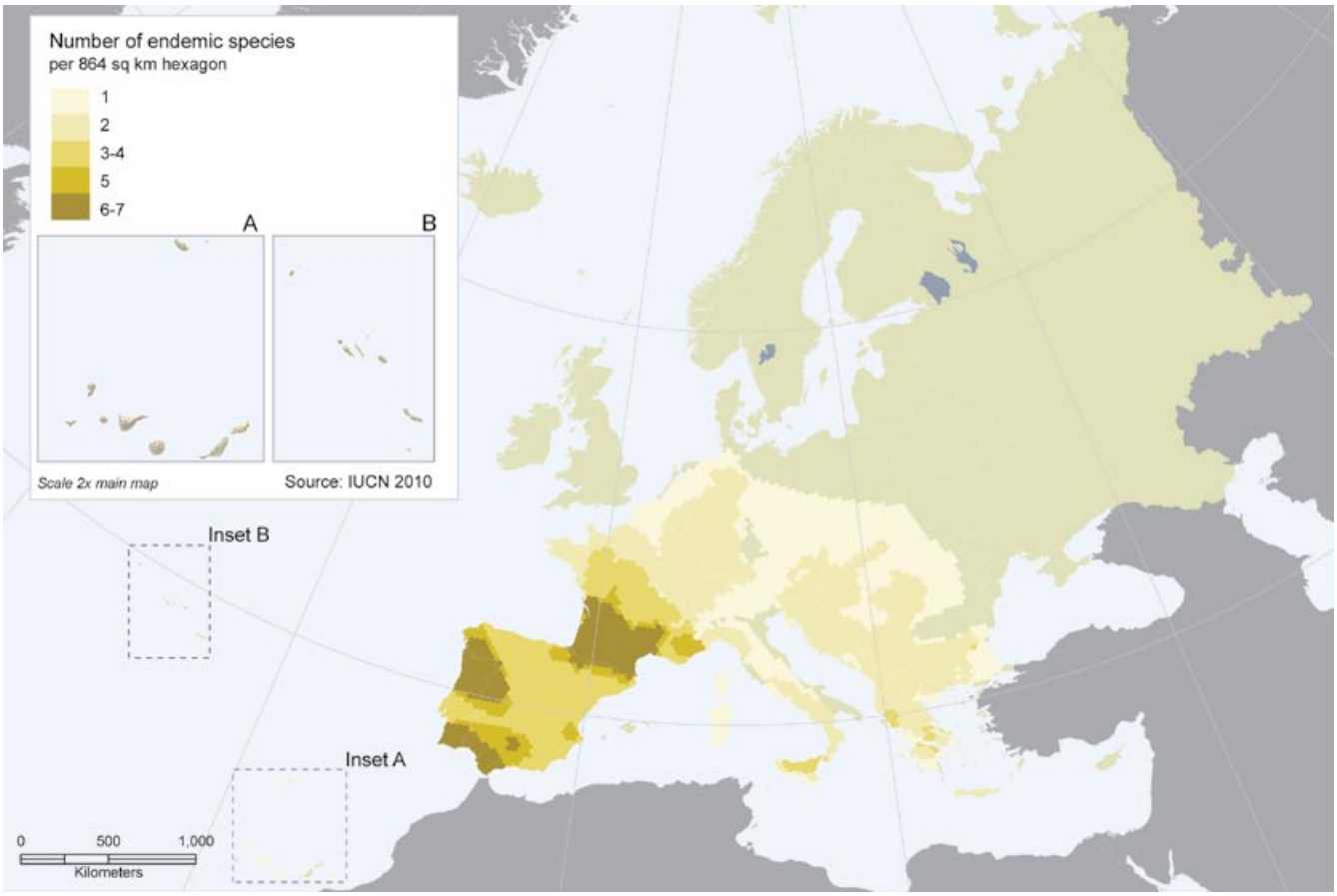
3.2 Endemic species richness

Figure 4 shows the distribution of endemic dragonfly species (i.e. those that are unique to Europe, being found nowhere else in the world). European dragonflies have relatively large ranges compared to the ranges of, for instance, butterflies or grasshoppers. Most species occurring in the northern half of Europe extend from western Europe to Siberia, sometimes reaching as far east as Kamchatka and Japan. The species found in the southern half of Europe tend to have smaller ranges. Out of the 18 endemic European species, all but *Cordulegaster bidentata* have their main distribution area in the southern half of Europe. Fifteen are either confined to islands, the Balkan Peninsula or the Iberian Peninsula and France. The three endemic species which do not fit into this pattern are *Cordulegaster bidentata*, which occurs in low and mid-mountain areas in Western, Central and Southern Europe, *C. trinacriae*, which occurs in southern continental Italy and Sicily and *Cordulegaster heros*, which is quite widespread in SE Europe, although its eastern range is not yet clear.

Island endemics – Four European species are endemic to islands: two on Crete (*Coenagrion intermedium* and *Boyeria cretensis,* which are uncommon and threatened; especially the latter occurs in low numbers), one on the Canary Islands and Madeira archipelago (*Sympetrum nigrifemur*) and one on the islands of Corsica, Sardinia, Sicily, Malta, Capraia, Elba and Giglio (*Ischnura genei*). The two latter species are not uncommon, and are consequently assigned to Least Concern.

Balkan Peninsula endemics – The five (sub)species endemic to the Balkan Peninsula are confined to Greece (*Cordulegaster helladica helladica*, *C. h. kastalia* and *C. h. buchholzi*), to western Greece and southern Albania

Figure 4. Distribution of endemic dragonflies in Europe



(*Pyrrhosoma elisabethae*) or to eastern Greece, southeastern Bulgaria and European Turkey (*Somatochlora borisi*). In the regions were these taxa occur, there is a high pressure on the freshwater ecosystems, and all of them are threatened.

Iberian / western European endemics – One European endemic, *Gomphus pulchellus*, is common in the westernmost part of Europe, except for the British Isles, and is not threatened. Five species have the core of their range on the Iberian Peninsula and in the southern half of France. Three of these (*Calopteryx xanthostoma*, *Platycnemis acutipennis* and *Platycnemis latipes*) are common within their relatively large ranges, and are not threatened. The two others (*Gomphus graslinii* and *Macromia splendens*) have a more restricted range. They are confined to major rivers, and are considered to be threatened. One additional species, *Oxygastra curtisii*, is almost endemic to South-Western Europe except for three small populations in Morocco. It is classified as Near Threatened.

3.3 Threatened dragonflies

A list of the dragonfly species present in Europe, along with their IUCN Red List status, is found in Appendix 1. At the European geographical level, 15% of the assessed dragonfly (sub)species are threatened, with 2% being Critically Endangered, 4% Endangered and 9% Vulnerable. Within the EU 27, the pattern is similar: 16% of the taxa are threatened, with a roughly similar breakdown between the three threatened categories (Table 2 and Figures 5 and 6). An additional 11% are considered Near Threatened in Europe. By comparison, 23% of the amphibians, 19% of the reptiles, 15% of the mammals, 13% of the birds, 11% of the saproxylic beetles and 9% of the butterflies in Europe are threatened (Temple & Cox 2009, Cox & Temple 2009, Temple & Terry 2007,

Table 2. The number of dragonfly (sub)species in each Red List Category

	IUCN Red List categories	No. (sub)species Europe (no. endemic species)	No. species EU 27 (no. endemic species)
Threatened categories	Critically Endangered (CR)	3 (2)	3 (1)
	Endangered (EN)	5 (3)	6 (3)
	Vulnerable (VU)	13 (3)	13 (2)
	Near Threatened (NT)	15 (4)	18 (2)
	Least Concern (LC)	96 (6)	91 (6)
	Data Deficient (DD)	5 (0)	3 (0)
	Total number of species assessed*	137 (18)	134 (14)

*Excluding the 5 species considered as Not Applicable.

Figure 5. Red List status of dragonflies in Europe.
See Table 2 for abbreviations.

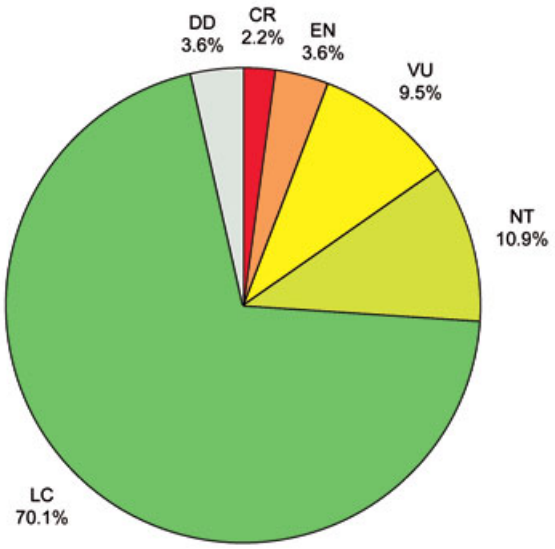


Figure 6. Red List status of dragonflies in the EU 27.
See Table 2 for abbreviations.

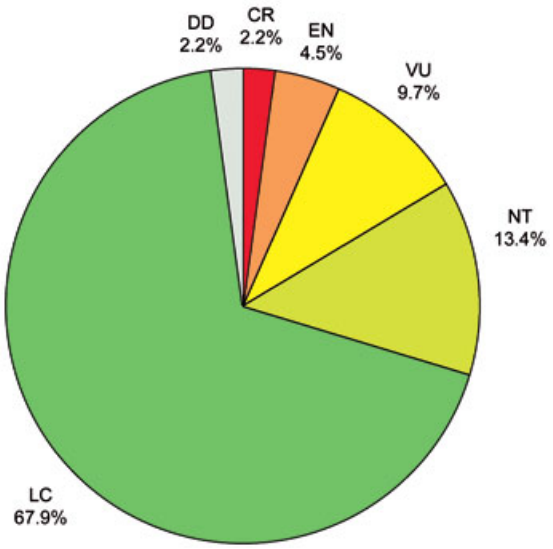


Table 3. Red List Status (European Regional level) of dragonflies by family. The table is almost the same for the EU27 region, with the exception that *Nehalennia speciosa* (Coenagrionidae) is added to VU, increasing the percentage of threatened species within this family to 23 percent.

Suborder	Family	Total*	CR	EN	VU	NT	LC	DD	% Threatened*
Damselflies	Calopterygidae	4					4		0%
	Epallagidae	1				1			0%
	Lestidae	9			1		8		11,1%
	Coenagrionidae	30	2		4	4	18	2	20,0%
	Platycnemididae	3					3		0%
Dragonflies	Aeshnidae	19		1	1	2	15		10,5%
	Gomphidae	15		1	1	4	8	1	13,3%
	Cordulegastridae	9	1	3	1	3	1		55,6%
	Macromiidae	1			1				100%
	Corduliidae	11			1	1	7	2	9,1%
	Libellulidae	35			3		32		8,6%
Total		**137**	**3**	**6**	**12**	**15**	**96**	**5**	**15,3%**

*Excluding the 5 species considered as Not Applicable.

Table 4. Threatened dragonfly species at the European and EU 27 level. Species endemic to Europe or to EU 27 are marked with an asterisk (*).

Family	Species	Common Name	Europe	EU 27	Distribution
Coenagrionidae	*Ceriagrion georgifreyi*	Turkish Red Damsel	CR	CR	Balkan Peninsula
Coenagrionidae	*Pyrrhosoma elisabethae*	Greek Red Damsel	CR *	CR	Balkan Peninsula
Cordulegastridae	*Cordulegaster helladica ssp. kastalia*	Delphi Goldenring	CR *	CR *	Balkan Peninsula
Aeshnidae	*Boyeria cretensis*	Cretan Spectre	EN *	EN *	Crete
Gomphidae	*Onychogomphus costae*	Faded Pincertail	EN	EN	Iberian Pen. & S France
Cordulegastridae	*Cordulegaster helladica ssp. buchholzi*	Buchholz' Goldenring	EN *	EN *	Balkan Peninsula
Cordulegastridae	*Cordulegaster helladica ssp. helladica*	Greek Goldenring	EN *	EN *	Balkan Peninsula
Cordulegastridae	*Cordulegaster insignis*	Blue-eyed Goldenring	EN	EN	Balkan Peninsula
Lestidae	*Lestes macrostigma*	Dark Spreadwing	VU	EN	Mediterranean
Coenagrionidae	*Coenagrion hylas*	Frey's Damselfly	VU	VU	Central Europe
Coenagrionidae	*Coenagrion intermedium*	Cretan Bluet	VU *	VU *	Crete
Coenagrionidae	*Ischnura fountaineae*	Oasis Bluetail	VU	VU	Pantelleria
Coenagrionidae	*Ischnura hastata*	Citrine Forktail	VU	VU	Azores
Aeshnidae	*Anax immaculifrons*	Magnificent Emperor	VU	VU	Balkan Peninsula
Gomphidae	*Lindenia tetraphylla*	Bladetail	VU	VU	Mediterranean
Cordulegastridae	*Cordulegaster picta*	Turkish Goldenring	VU	VU	Balkan Peninsula
Macromiidae	*Macromia splendens*	Splendid Cruiser	VU *	VU *	Iberian Pen. & S France
Corduliidae	*Somatochlora borisi*	Bulgarian Emerald	VU *	VU	Balkan Peninsula
Libellulidae	*Orthetrum nitidinerve*	Yellow-veined Skimmer	VU	VU	Iberian Pen. & S France
Libellulidae	*Sympetrum depressiusculum*	Spotted Darter	VU	VU	S & C Europe
Libellulidae	*Zygonyx torridus*	Ringed Cascader	VU	VU	Iberian Pen. & Sicily
Coenagrionidae	*Nehalennia speciosa*	Sedgling	NT	VU	Central & NE Europe

BirdLife International 2004, Nieto & Alexander 2010, Van Swaay *et al.* 2010)

Table 3 gives an overview of threatened taxa per family. In most families between 0 and 14 percent of the taxa are threatened. Exceptions to this are the Coenagrionidae (20%), the Cordulegastridae (56%) and the single species of Macromiidae (100%). The high percentage of threatened Cordulegastridae is largely due to their habitat choice, small runnels and streams, and their restricted range. These habitats are prone to desiccation due to climate change, fires and increased water extraction.

The distribution of threatened dragonflies in Europe (Figure 7) reveals a somewhat different pattern than the depiction of overall species diversity. Eighteen of the 22 threatened (sub)species are almost entirely confined to the Mediterranean (Table 4). The exceptions are *Coenagrion hylas, Ischnura hastata*, *Nehalennia speciosa* and *Sympetrum depressiusculum*. Within Mediterranean Europe, there is a very clear concentration of threatened species in the Balkan Peninsula and Crete, with twelve out of the 22 threatened European (sub)species not occurring in other parts of Europe. A second concentration of threatened species is found on the Iberian Peninsula and in southern France, with four threatened species largely confined to this area.

Figure 8. Population trends of European dragonflies.

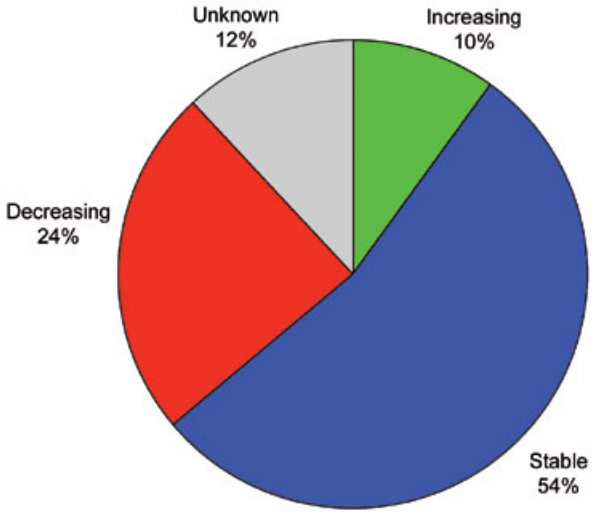
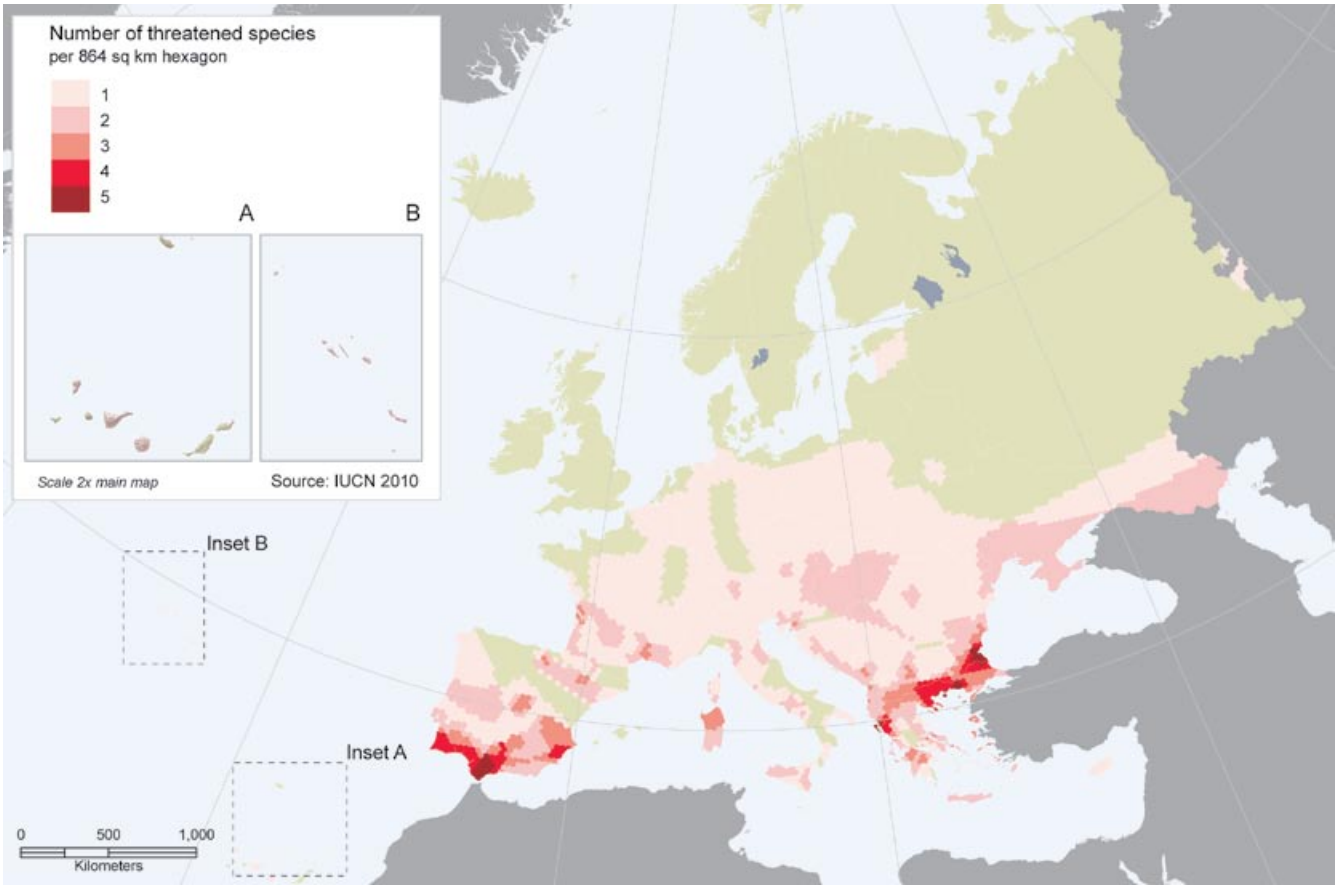


Figure 7. Distribution of threatened dragonflies in Europe.



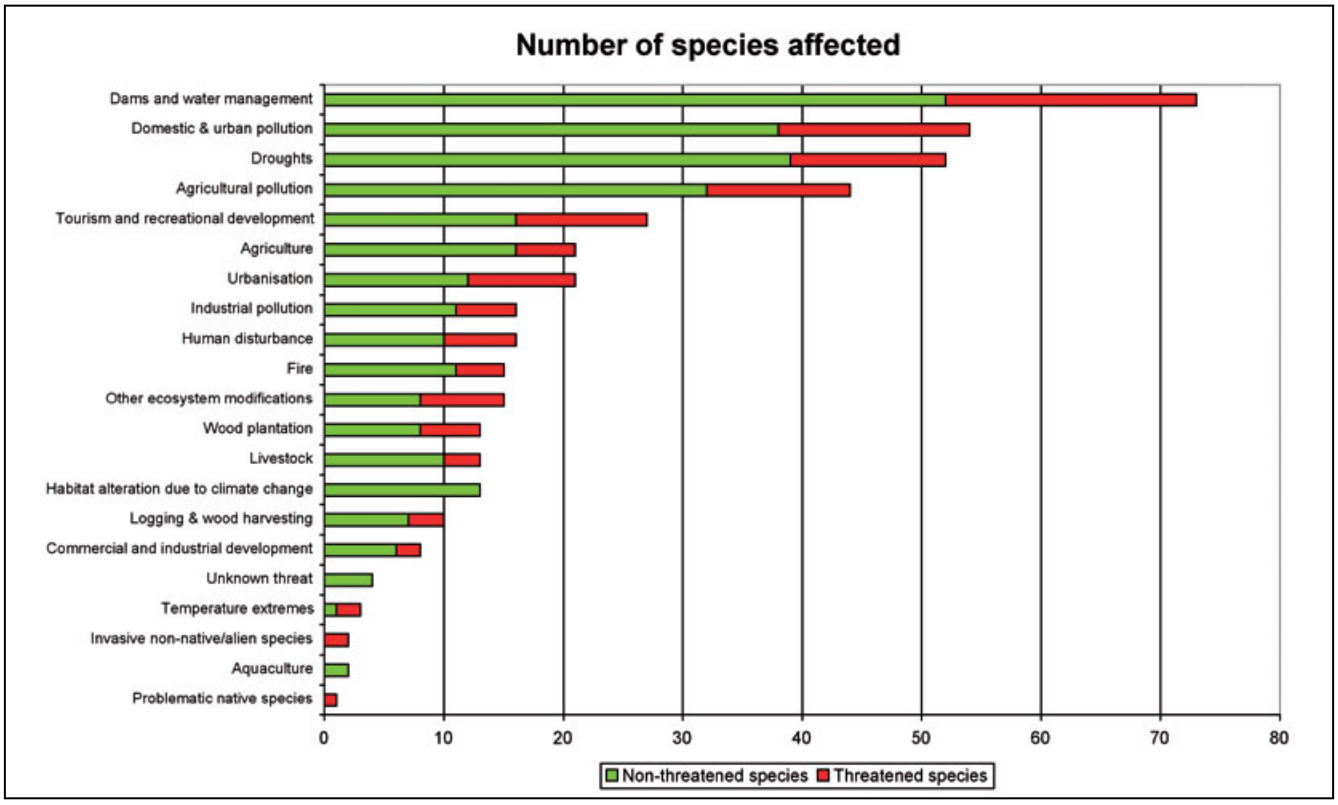
3.4 Major threats to dragonflies in Europe

Figure 8 shows the population trends of the European dragonflies. Half of the European species have a stable population trend; about a quarter of them are declining and about one tenth are increasing. The threats to European dragonflies vary regionally and over time. During most of the twentieth century, large-scale land conversion, canalisation of rivers and water pollution (including eutrophication) were the main causes of decline, impacting especially species dependent on mesotrophic or running waters. Declines were particularly severe in Western Europe from the 1960s to the 1980s, when several species became extinct over large areas. Since then, improved water management and decreasing eutrophication have had a positive impact, and many of the species dependent on running waters have made a surprisingly fast recovery. Recently, there have been some indications that also species dependent on mesotrophic waters are starting to recover.

The conservation status of dragonflies in Central and Northern Europe has improved in recent decades, and is now generally considered to be good. In the Mediterranean region, the threats to dragonflies are, however, increasing rapidly. The smaller distribution areas of most Mediterranean dragonflies, combined with these increasing threats, make that most threatened dragonflies are currently found in the Mediterranean Basin. A summary of the relative importance of the different threats is shown in Figure 9.

Fifteen out of the 22 threatened species are dependent on running water. All of these species are confined to the Mediterranean. They are impacted by the increasing demand for water for irrigation and for consumption by the growing (tourist) population, as well as by the increased frequency and duration of hot and dry periods. River species are adversely affected by the construction of dams and reservoirs as well as by desiccation and (to a lesser extent) deteriorating water quality. Species associated with smaller streams are declining due to desiccation caused by dry weather, fires and increased water extraction for local agriculture. Several of these species occur in small brooks and seepage areas which, due to their small size, can be destroyed by a local event, such as a fire, the construction of a house or the extraction of water by an individual farmer.

Figure 9. Major threats to dragonflies in Europe



4. Conservation priorities

4.1 General

Many species require a combination of conservation measures to ensure their continued survival. These measures may include legislation, research, monitoring, population management, and land acquisition or control. Although time-limited or local actions are important to the conservation of dragonflies, they are unlikely to be strong and sustainable enough to prevent the extinction of species already threatened across their entire range. Long-term coordinated actions are therefore required at the regional, national and international level.

The protection of sites plays a crucial role in all effective conservation strategies. Several international treaties call for the selection and protection of sites on the basis of their importance to biodiversity. In Europe, the primary mechanism for site protection is the Natura 2000 network of protected areas. The distribution data presented in Boudot *et al.* (2009) could be used to fine-tune the selection of dragonfly conservation areas. Many European countries have no formal schemes for monitoring common and widespread species, let alone those under threat. One of the future challenges is to improve the monitoring in order to increase the quantity and quality of the available information. The results presented here need to be updated and improved in the future to meet this challenge. National dragonfly population monitoring schemes have started in some EU member countries. For example in the Netherlands, the Dutch Butterfly Conservation has set up a surveillance and monitoring network aiming at providing information on the distribution and populations trends for all Dutch butterfly and dragonfly species.

4.2 Legislation

The EU nature conservation policy is based on two main pieces of legislation - the Birds Directive and the Habitats Directive. The main aim of this nature conservation policy is to ensure a favourable conservation status for the habitats and species found in the EU. One of the main tools to acheive this is the Natura 2000 network of protected areas. EU nature conservation policy also foresees the integration of its protection requirements into other EU sectoral policies such as agriculture, regional development and transport. The Habitats Directive applies to terrestrial, freshwater and marine regions. Each Member State is required to identify sites of European importance and encouraged to design and implement a special management plan to protect them, combining long-term conservation with economic and social activities as part of a sustainable development strategy. These sites, together with those of the Birds Directive, make up the Natura 2000 network - the cornerstone of the EU nature conservation policy.

The Habitats Directive contains a series of Annexes, which mainly identify habitats and species of European Community concern. The Member States are required to designate Natura 2000 sites for the species listed on Annex II and Annex IV, which are subject to a strict protection system. Table 5 shows the species identified as threatened, and their inclusion among the protected species in the Annexes of the Habitats Directive.

A total of sixteen European dragonflies are listed on the Annexes of the Habitats Directive (Table 5). Of the 22 threatened European species, only three are listed on the Annexes of the Habitats Directive. The reason for this miss-match is that the list of species included on the Habitats Directive was compiled in the 1980s and has a bias towards western European species which, at that time, showed a strong decline. Since then, the decline of many of those species has stopped, and some of them even show a clear recovery. Moreover, increased knowledge of their distribution and conservation status has shown that some of them are less rare as hitherto thought. The species included in the Habitats Directive are still valid, as they are good indicators of the habitat quality of many rare habitats. The other threatened European dragonfly species would benefit from being listed in the Annexes of the Habitats Directive, as this is often the only means of ensuring a strict and long term protection of species and sites.

4.3 Regional actions

This report shows where the highest diversity, highest level of endemism and highest portion of threatened dragonflies are found within the European region. Based on this, three areas of high conservation concern for European dragonflies become evident: Crete, the southern Balkans and the Iberian Peninsula/southern France. These areas are discussed below, and for each area the conservation actions are prioritised. Six species that fall outside these regions are discussed separately.

Table 5. Dragonflies which are either threatened or listed on Annexes II or IV of the Habitats Directive. Species endemic to Europe or to EU 27 are marked with an asterisk (*).

Family	Species	Common Name	Europe	EU 27	Annexes II	Annexes IV
Coenagrionidae	*Ceriagrion georgifreyi*	Turkish Red Damsel	CR	CR		
Coenagrionidae	*Pyrrhosoma elisabethae*	Greek Red Damsel	CR *	CR		
Cordulegastridae	*Cordulegaster helladica ssp. kastalia*	Delphi Goldenring	CR *	CR *		
Aeshnidae	*Boyeria cretensis*	Cretan Spectre	EN *	EN *		
Gomphidae	*Onychogomphus costae*	Faded Pincertail	EN	EN		
Cordulegastridae	*Cordulegaster helladica ssp. helladica*	Greek Goldenring	EN *	EN *		
Cordulegastridae	*Cordulegaster helladica ssp. buchholzi*	Buchholz' Goldenring	EN *	EN *		
Cordulegastridae	*Cordulegaster insignis*	Blue-eyed Goldenring	EN	EN		
Lestidae	*Lestes macrostigma*	Dark Spreadwing	VU	EN		
Coenagrionidae	*Coenagrion hylas*	Frey's Damselfly	VU	VU	●	●
Coenagrionidae	*Coenagrion intermedium*	Cretan Bluet	VU *	VU *		
Coenagrionidae	*Ischnura fountaineae*	Oasis Bluetail	VU	VU		
Coenagrionidae	*Ischnura hastata*	Citrine Forktail	VU	VU		
Aeshnidae	*Anax immaculifrons*	Magnificent Emperor	VU	VU		
Gomphidae	*Lindenia tetraphylla*	Bladetail	VU	VU	●	●
Cordulegastridae	*Cordulegaster picta*	Turkish Goldenring	VU	VU		
Macromiidae	*Macromia splendens*	Splendid Cruiser	VU *	VU *	●	●
Corduliidae	*Somatochlora borisi*	Bulgarian Emerald	VU *	VU		
Libellulidae	*Orthetrum nitidinerve*	Yellow-veined Skimmer	VU	VU		
Libellulidae	*Sympetrum depressiusculum*	Spotted Darter	VU	VU		
Libellulidae	*Zygonyx torridus*	Ringed Cascader	VU	VU		
Coenagrionidae	*Nehalennia speciosa*	Sedgling	NT	VU		
Coenagrionidae	*Coenagrion mercuriale*	Mercury Bluet	NT	NT	●	
Coenagrionidae	*Coenagrion ornatum*	Ornate Bluet	NT	NT	●	
Aeshnidae	*Aeshna viridis*	Green Hawker	NT	NT		●
Gomphidae	*Gomphus graslinii*	Pronged Clubtail	NT	NT	●	●
Cordulegastridae	*Cordulegaster heros*	Balkan Goldenring	NT	NT	●	●
Cordulegastridae	*Cordulegaster trinacriae*	Italian Goldenring	NT	NT	●	●
Corduliidae	*Oxygastra curtisii*	Orange-spotted Emerald	NT	NT	●	●
Libellulidae	*Leucorrhinia albifrons*	Dark Whiteface	LC	NT		●
Libellulidae	*Leucorrhinia caudalis*	Lilypad Whiteface	LC	NT		●
Lestidae	*Sympecma paedisca*	Siberian Winter Damsel	LC	LC		●
Gomphidae	*Gomphus flavipes*	River Clubtail	LC	LC		●
Gomphidae	*Ophiogomphus cecilia*	Green Snaketail	LC	LC	●	●
Libellulidae	*Leucorrhinia pectoralis*	Yellow-spotted Whiteface	LC	LC	●	●

Crete

The dragonfly fauna of Crete is not exceptionally rich and diverse, but it features two endemic species: *Coenagrion intermedium* and *Boyeria cretensis*. They breed in shaded areas mainly in the upper courses of some small rivers, and are currently known from only 9 and 11 river systems, respectively. The protection of running waters and their forest environment is rather poor in Crete, and the rapid increase of spring capture throughout the whole of Greece to compensate for the current rainfall deficit is an additional threat.

- The conservation of these two species necessitates the prohibition of any additional spring capture.
- Better knowledge of the distribution of *Boyeria cretensis* and *Coenagrion intermedium* is needed in order to assess their long-term survival chances.
- A freshwater action plan is needed for Crete. It should include an assessment of the quality and conservation status of the freshwater habitats (especially brooks). Based on this assessment it will be decided whether the current situation is compatible with the conservation of freshwater biodiversity, or if a restoration procedure should be initiated.

Southern Balkans

The southern Balkan area has a rich dragonfly fauna, including several endemic species. Nature organizations are not very strong in the area, and there seems to be a lower level of awareness of nature conservation compared to other parts of Europe. Many of the regional species live in brooks, and these habitats are strongly affected by agricultural intensification, urban development and pollution. In addition, climate change is impacting these habitats severely, resulting in the desiccation of many streams and rivers during the summer. Three of the most threatened dragonflies of Europe (*Pyrrhosoma elisabethae*, *Cordulegaster helladica* ssp. and *Somatochlora borisi*) are endemic to the brooks and small rivers of Greece and nearby countries (Albania, Bulgaria and European Turkey). If no action is taken, these species may become extinct during the first half of this century.

- It is advisable that species action plans be made for these three taxa.
- A small part of the range of *Somatochlora borisi* is included in the WWF Dadia protected area in North-Eastern Greece. This protected area should be extended to include the entire range of this species

Greek Goldenring *Cordulegaster helladica* (Vulnerable). The three subspecies of the Greek Goldenring are all confined to small areas in Greece where they occur at brooks.
Photo © Jean-Pierre Boudot.

(Greece, Bulgaria and north-European Turkey) to create an international protected area, ensuring the conservation of the original deciduous forest and the traditional extensive rearing of goats and sheep.

- Many of the rivers where this species occurs have dried out during recent dry and hot summers. During these periods, the larvae of the species survive in stagnant parts of the streams. This is, however, a suboptimal habitat for the species, and the drought will almost certainly lead to a decline in numbers. For this reason, water capture and irrigation should be prohibited from late spring to the next rain season in autumn or early winter.
- In addition, total protection should be granted to the places where *Pyrrhosoma elisabethae* and *Cordulegaster helladica* occur, conserving the currently prevalent environmental conditions and prohibiting water capture in the upper courses of the brooks and rivers.

The other five species (*Ceriagrion georgifreyi*, *Anax immaculifrons*, *Lindenia tetraphylla*, *Cordulegaster insignis* and *C. picta*) are not endemic to Europe, and have part of their range in Asia. With the exception of *Lindenia tetraphylla*, their European distribution is, however, confined to small parts of the southern Balkans. This applies especially to *Ceriagrion georgifreyi*, a species associated with seepages and small streams known from the Greek islands Thásos, Zákinthos and Kérkira (Corfu). Fieldwork to relocate the European populations, followed by local conservation is needed to prevent this species from going extinct in Europe.

Iberian Peninsula/Southern France

All five threatened species of the western Mediterranean have relatively large ranges. Only *Macromia splendens* is endemic to Europe. Recent data on the trend of this species shows mixed results. A number of new populations have been found on the Iberian Peninsula and in France during the last decade, probably as a result of intensified fieldwork. However steep declines have been noticed in other parts of its range in France. Information on three of the Iberian species is remarkably scant. *Zygonyx torridus* is widespread in Africa, but in Europe this species is confined to a small number of localities on the Iberian Peninsula and the Canary Islands. Information about the number of populations and their size is poor due to the paucity of records, and some of the records might refer to wanderers. The two other species, *Onychogomphus costae* and *Orthetrum nitidinerve*, are endemic to the Maghreb region and the Iberian Peninsula. In Europe, both species are associated with major river systems, but details about their habitat choice are largely lacking from Spain and Portugal. In the Maghreb *Orthetrum nitidinerve* has its strongest populations in brooks, springs and seepage, but this does not seem to be the case in Europe. Both species appear to be declining throughout their Iberian range, probably due to desiccation of streams and seepage areas, and deterioration of the water quality.

The following actions should be taken:

- Research on the distribution, population size and permanency of *Zygonyx torridus*. Most of these populations are probably very small and/or localised. Based on the results, action plans on the local level should be made.
- In the coming decade, pressure on larger brooks and rivers on the Iberian Peninsula and in southern France will increase due to the higher demand for water combined with longer periods of hot and dry weather. For this reason, it is necessary to design large scale multi-taxa conservation plans for river systems where actions ensuring the balance between agriculture, development and biodiversity conservation are proposed. Information underpinning such action plans can be derived from the outcomes of the Mediterranean Freshwater Assessment (Riservato *et al.* 2009). For *Onychogomphus costae* and *Orthetrum nitidinerve* it will be necessary to gather additional data on the distribution and habitat requirements of the species.

Others

Six threatened European species, none of them endemic to Europe, are not found in any of the three areas discussed above. *Ischnura fountaineae* and *I. hastata* are both confined to standing waters on the Italian island of Pantelleria (71 km east of Tunisia) and in the Azores archipelago, respectively. These species may relatively easily be preserved by means of local conservation efforts. *Coenagrion hylas* is at present confined to 14 reproducing populations in Austria. It receives ample attention from conservationists (Life-project Tirol Lech of the EU), and its population currently seems stable. It might, however, become threatened in the future due to climate change. *Nehalennia speciosa* is the only threatened species where the European range is almost completely confined to the northern half of Europe. The species inhabits mesotrophic fens, bogs and lakes, but it has strict demands regarding the water depth and the vegetation structure. The species is a weak disperser and most of its populations are very isolated. The amount of locally available habitats could be increased in order to strengthen and reconnect these

isolated populations. The remaining two species have relatively large ranges. *Lestes macrostigma* is found along large parts of the Mediterranean coast, at certain sites along the Atlantic coast of France and in the Hungarian plains. It favours slightly brackish, ephemeral standing waters. Its population densities vary strongly from one year to another, making it difficult to assess a trend. It is, however, probably declining along the Mediterranean coast due to the increased pressure on coastal wetlands. A study on the conservation of this species has been initiated in the Camargue (France). The other widespread but threatened European species is *Sympetrum depressiusculum*. This species has a large range in Southern Europe, where it is mainly found in rice fields, and in Central Europe, where it occurs mainly in fishponds and lakes. The species used to be relatively common, and was even very abundant locally, in certain parts of its range. Changes in the management of fishponds and rice fields have, however, caused a severe decline in Central and South Europe. Influencing the management practices of rice fields is one of the best ways to preserve this species, together with protection of the last marshes where it survives in Western Europe. In the latter habitat, it is sometimes threatened by conservation measures aiming to protect other species. It is possible to increase the biological value of rice fields by changing the hydrological management and decreasing the amount of pesticides used without having extra costs in the long term. Research on and implementation of better management practices for rice fields are needed.

4.4 Dragonflies as tools: databases and monitoring

In a number of European countries, dragonflies are used as indicators of freshwater habitat quality. They have the advantage that information about the adults can be collected relatively easily, as most species can be identified on sight. Dragonflies are increasingly popular with volunteers, and are liked by the general public. As such, they can be used as ambassadors of freshwater habitat conservation, raising the awareness among non-specialists.

In order to use dragonflies as a quality indicator, up-to-date information on their distribution is needed. For specific projects individual specialists can gather information, but to obtain countrywide data it is far more cost-effective to establish a network of volunteers. Such networks have been implemented in several western European countries such as France, Belgium and Great Britain. Constructing a network of volunteers is time consuming, and requires financial support. Sadly, the countries with the highest number of threatened dragonflies have a relatively poorly developed network of volunteers. Some countries, e.g. Greece, do not have any resident odonatologists, which means that all knowledge about their dragonfly fauna is gathered by foreigners. In other countries, the number of volunteers is growing steadily, but networks are lacking and centralised collection of data is poorly developed due to the lack of funding. This is the situation in countries such as Italy, Spain and Portugal. These countries should invest in a network of volunteers in order to collect more extensive distribution data. Such efforts should include the publication of updated identification tools in the local language, and the creation of an internet facility for storing the records.

Dragonflies can serve as reliable indicators of habitat quality, and they are suitable for monitoring the overall quality of freshwater habitats. Several European countries have monitoring schemes running. By exchanging information it would be possible to calculate regional trends for dragonflies. By slowly expanding such a network, it would be possible to monitor also European trends, which might be used to measure the results of European conservation efforts. Information about monitoring methods can be obtained from the Butterfly Conservation, The Netherlands.

Rivers and brooks in the Mediterranean have often a rich dragonfly fauna and are increasingly impacted by desiccation. Photo © Vincent Kalkman.

5. Conclusion and recommendations

This report shows where the highest diversity, the highest level of endemism and the largest number of threatened dragonflies are found within the European region (Figure 3, 4 and 7). The highest diversity is found in the southern parts of central Europe where species of the Mediterranean co-occur with species of a more temperature climate.

Twenty-two (15%) of the 137 assessed (sub) species fall into a threat category, with 2% being Critically Endangered, 4% Endangered and 9% Vulnerable. A similar proportion is threatened at the EU level. Eighteen of the threatened species are largely confined to the Mediterranean, fifteen of these being dependent on running water.

Main threats to these species are the increasing demand for water and the increased frequency and duration of hot and dry periods. River species are affected by the construction of dams and reservoirs as well as by desiccation and (to a lesser extent) deteriorating water quality. Species associated with smaller streams are declining due to desiccation caused by dry weather, fires and increased water extraction for local agriculture.

Three areas of high conservation priority with regard to European dragonflies have become evident: Crete, the southern Balkans and the Iberian Peninsula/southern France. These priorities do not mean that no action is needed in other regions. Areas like northern Italy also have major problems with the conservation of freshwater habitats. These areas do, however, hold fewer threatened or endemic species, and are therefore less prioritized. Furthermore, it has become apparent that there is a strong need to increase the knowledge of dragonfly distribution in some countries, to initiate monitoring schemes, and to develop databases. Four top priorities have been identified for Europe:

The southern Balkans

Three of the most threatened dragonflies in Europe are almost completely confined to the southern Balkans. Greece in particular needs to develop species action plans for *Pyrrhosoma elisabethae* and *Cordulegaster helladica* ssp. and for *Somatochlora borisi* in cooperation with Bulgaria and Turkey. Measures that should be implemented include the development of odonatological and environmental studies, as well as active efforts to increase the awareness of nature conservation issues, including legislation and application. These measures might, for instance, help to prevent great lakes from being drained due to maize irrigation and streams from drying up due to water capture at springs.

Crete

Crete holds two endemic dragonfly species (*Coenagrion intermedium* and *Boyeria cretensis*), which are both threatened. The quality of the brooks where these species are found is deteriorating due to climate change, the increased demand for irrigation water and the removal of forest. A freshwater conservation plan for Crete is needed.

Iberian Peninsula/southern France

Three of the four threatened Iberian dragonflies are largely dependent on large streams and river systems. Currently, climate change and an increased demand for water impact these systems strongly. Based on the information gathered for the Red List Assessment of European Dragonflies, a joint management plan for the rivers of the Iberian Peninsula needs to be developed and implemented by Portugal and Spain.

Volunteers

Information about the distribution of dragonflies collected by volunteers is very useful to conservation management. Volunteers interested in dragonflies increase the local commitment to conservation of freshwater habitats. For these reasons, it is important to enable experts to invest time in building a network of volunteers, in training others and in collecting data in a standardised way. Especially in the Mediterranean, the interest in dragonflies is growing, and the support of local networks is vital to nature conservation.

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Appendix 1. Red List status of European dragonflies

For each European species the Red List status in Europe and the Red List status in EU27 is presented. In addition to this, it is stated if a species is endemic to Europe or to EU27, and the population trend is stated.

See Figure 1 for a presentation of IUCN Red List Categories

	IUCN Red List Category (Europe)	IUCN Red List Category (EU27)	Endemic to Europe	Endemic to EU27	Population trend
CALOPTERYGIDAE					
Calopteryx haemorrhoidalis	LC	LC			Stable
C. splendens	LC	LC			Stable
C. virgo	LC	LC			Stable
C. xanthostoma	LC	LC	Endemic	Endemic	Stable
EPALLAGIDAE					
Epallage fatime	NT	NT			Decreasing
LESTIDAE					
Lestes barbarus	LC	LC			Stable
L. dryas	LC	LC			Stable
L. macrostigma	VU	EN			Decreasing
L. parvidens	LC	DD			Unknown
L. sponsa	LC	LC			Stable
L. virens	LC	LC			Stable
L. viridis	LC	LC			Stable
Sympecma fusca	LC	LC			Stable
S. paedisca	LC	LC			Decreasing
COENAGRIONIDAE					
Ceriagrion georgifreyi	CR	CR			Decreasing
C. tenellum	LC	LC			Stable
Coenagrion armatum	LC	NT			Decreasing
C. caerulescens	NT	NT			Decreasing
C. ecornutum	DD	NE			Stable
C. hastulatum	LC	LC			Unknown
C. hylas	VU	VU			Stable
C. intermedium	VU	VU	Endemic	Endemic	Unknown
C. johanssoni	LC	LC			Stable
C. lunulatum	LC	LC			Unknown
C. mercuriale	NT	NT			Decreasing
C. ornatum	NT	NT			Decreasing
C. puella	LC	LC			Stable
C. pulchellum	LC	LC			Stable
C. scitulum	LC	LC			Stable
Enallagma cyathigerum	LC	LC			Stable
Erythromma lindenii	LC	LC			Stable
E. najas	LC	LC			Stable
E. viridulum	LC	LC			Increasing
Ischnura aralensis	DD	NE			Unknown
I. elegans	LC	LC			Stable
I. fountaineae	VU	VU			Unknown
I. genei	LC	LC	Endemic	Endemic	Stable
I. graellsii	LC	LC			Stable
I. hastata	VU	VU			Decreasing

	IUCN Red List Category (Europe)	IUCN Red List Category (EU27)	Endemic to Europe	Endemic to EU27	Population trend
I. pumilio	LC	LC			Stable
I. saharensis	LC	LC			Stable
Nehalennia speciosa	NT	VU			Decreasing
Pyrrhosoma elisabethae	CR	CR	Endemic		Decreasing
P. nymphula	LC	LC			Stable
PLATYCNEMIDIDAE					
Platycnemis acutipennis	LC	LC	Endemic	Endemic	Stable
P. latipes	LC	LC	Endemic	Endemic	Stable
P. pennipes	LC	LC			Stable
P. subdilatata	NA	NA			Unknown
AESHNIDAE					
Aeshna affinis	LC	LC			Increasing
A. caerulea	LC	LC			Decreasing
A. crenata	LC	NT			Stable
A. cyanea	LC	LC			Stable
A. grandis	LC	LC			Stable
A. isoceles	LC	LC			Stable
A. juncea	LC	LC			Stable
A. mixta	LC	LC			Increasing
A. serrata	LC	LC			Stable
A. subarctica	LC	LC			Decreasing
A. viridis	NT	NT			Decreasing
Anax ephippiger	LC	LC			Stable
A. immaculifrons	VU	VU			Unknown
A. imperator	LC	LC			Increasing
A. junius	NA	NA			Unknown
A. parthenope	LC	LC			Increasing
Boyeria cretensis	EN	EN	Endemic	Endemic	Decreasing
B. irene	LC	LC			Stable
Brachytron pratense	LC	LC			Stable
Caliaeschna microstigma	NT	NT			Decreasing
GOMPHIDAE					
G. flavipes	LC	LC			Increasing
G. graslinii	NT	NT	Endemic	Endemic	Decreasing
G. pulchellus	LC	LC	Endemic	Endemic	Stable
G. schneiderii	NT	NT			Unknown
G. simillimus	NT	NT			Decreasing
G. ubadschii	DD	DD			Unknown
G. vulgatissimus	LC	LC			Stable
Lindenia tetraphylla	VU	VU			Decreasing
Onychogomphus costae	EN	EN			Decreasing
O. forcipatus albotibialis	NT	NT			Decreasing
O. forcipatus forcipatus	LC	LC			Stable
O. forcipatus unguiculatus	LC	LC			Stable
O. uncatus	LC	LC			Stable
Ophiogomphus cecilia	LC	LC			Stable
Paragomphus genei	LC	LC			Stable
CORDULEGASTRIDAE					
Cordulegaster bidentata	NT	NT	Endemic		Decreasing
C. boltonii	LC	LC			Stable
C. helladica buchholzi	EN	EN	Endemic	Endemic	Decreasing
C. helladica helladica	EN	EN	Endemic	Endemic	Unknown
C. helladica kastalia	CR	CR	Endemic	Endemic	Decreasing
C. heros	NT	NT	Endemic		Stable
C. insignis	EN	EN			Unknown

	IUCN Red List Category (Europe)	IUCN Red List Category (EU27)	Endemic to Europe	Endemic to EU27	Population trend
C. picta	VU	VU			Stable
C. trinacriae	NT	NT	Endemic	Endemic	Decreasing
CORDULIIDAE					
Cordulia aenea	LC	LC			Stable
Epitheca bimaculata	LC	LC			Stable
Oxygastra curtisii	NT	NT			Stable
Somatochlora alpestris	LC	LC			Unknown
S. arctica	LC	LC			Unknown
S. borisi	VU	VU	Endemic		Decreasing
S. flavomaculata	LC	LC			Stable
S. graeseri	DD	NE			Unknown
S. meridionalis	LC	LC			Unknown
S. metallica	LC	LC			Stable
S. sahlbergi	DD	DD			Unknown
MACROMIIDAE					
Macromia splendens	VU	VU	Endemic	Endemic	Decreasing
LIBELLULIDAE					
Brachythemis impartita	LC	LC			Increasing
Crocothemis erythraea	LC	LC			Increasing
Diplacodes lefebvrii	LC	LC			Stable
Leucorrhinia albifrons	LC	NT			Stable
L. caudalis	LC	NT			Stable
L. dubia	LC	LC			Stable
L. pectoralis	LC	LC			Decreasing
L. rubicunda	LC	LC			Decreasing
Libellula depressa	LC	LC			Stable
L. fulva	LC	LC			Stable
L. quadrimaculata	LC	LC			Stable
Orthetrum albistylum	LC	LC			Increasing
O. brunneum	LC	LC			Increasing
O. cancellatum	LC	LC			Stable
O. chrysostigma	LC	LC			Stable
O. coerulescens	LC	LC			Stable
O. nitidinerve	VU	VU			Decreasing
O. sabina	LC	LC			Stable
O. taeniolatum	LC	LC			Stable
O. trinacria	LC	LC			Stable
Pantala flavescens	NA	NA			Unknown
Selysiothemis nigra	LC	LC			Increasing
Sympetrum danae	LC	LC			Stable
S. depressiusculum	VU	VU			Decreasing
S. flaveolum	LC	LC			Stable
S. fonscolombii	LC	LC			Increasing
S. meridionale	LC	LC			Increasing
S. nigrifemur	LC	LC	Endemic	Endemic	Decreasing
S. pedemontanum	LC	LC			Stable
S. sanguineum	LC	LC			Stable
S. sinaiticum	LC	LC			Stable
S. striolatum	LC	LC			Stable
S. vulgatum	LC	LC			Stable
Trithemis annulata	LC	LC			Increasing
T. arteriosa	NA	NA			Unknown
T. festiva	LC	LC			Stable
T. kirbyi	NA	NA			Increasing
Zygonyx torridus	VU	VU			Decreasing

Appendix 2. Number of dragonfly species recorded in the European countries

Including species classed as Not Applicable, vagrants and nationally extinct species. The numbers within brackets refer to additional species which are known from unconfirmed records only. * The species number for Russia refers to species occurring in the European part minus the Caucasus region.

Country	Total number of species
Albania	53 (2)
Andorra	15
Austria	77
Belarus	63
Belgium	69
Bosnia Herzegovina	57 (1)
Bulgaria	67
Cyprus	36
Croatia	66
Czech Republic	71 (2)
Denmark	58
Estonia	54
Finland	55
France	93
Germany	81
Greece	77 (2)
Hungary	66
Iceland	1
Ireland	29
Italy	90
Latvia	59
Liechtenstein	20

Country	Total number of species
Lithuania	61
Luxembourg	62
Macedonia	60
Malta	15
Moldova	37 (2)
Montenegro	65
Netherlands	71
Norway	48
Poland	73
Portugal	65 (1)
Romania	67 (2)
Russia*	74
Serbia	61 (1)
Slovakia	73
Slovenia	71 (1)
Spain	82
Sweden	61
Switzerland	77 (1)
Turkey in Europe	56
Ukraine	73 (2)
United Kingdom	55

Appendix 3. Example species summary and distribution map

The species summary presents all information collated (for each species) during this assessment, including a distribution map. You can search for and download all the summaries and distribution maps from the European Red List website and data platform, available online at http://ec.europa.eu/environment/nature/conservation/species/redlist and http://www.iucnredlist.org/europe

Somatochlora borisi - Marinov, 2001

ANIMALIA - ARTHROPODA - INSECTA - ODONATA - CORDULIIDAE - Somatochlora - borisi

Common Names: Rhodopen-Smaragdlibelle (German), Cordulie de Bulgarie (French), Bulgarian Emerald (English)
Synonyms: Corduliochlora borisi (Marinov, 2001) ;

Taxonomic Note:
Marinov & Seidenbusch (2007) place this taxon in a new monotypic genus, *Corduliochlora*. We refrain from using *Corduliochlora* as long as no overall phylogenetic study of the Corduliidae has been undertaken.

Red List Assessment

Red List Status

VU - Vulnerable, C1+2a(i) (IUCN version 3.1)

Assessment Information

Evaluated?	Date of Evaluation:	Status:	Reasons for Rejection:	Improvements Needed:
True	2009-04-25	Passed	-	-

Assessor(s): Boudot, J.-P.

Evaluator(s): De Knijf, G., Ferreira, S. & Riservato, E.

Assessment Rationale

European regional assessment: Vulnerable (VU)
EU 27 regional assessment: Vulnerable (VU)

Currently there are no threats from traditional human activities in the area. However, future intensification of agriculture and of conifer plantations in connection to the extension of the European Union represent notable threats for the next 10 years. In addition, current climate warming with increased frequency, length and intensity of drought periods constitute a very strong threat for the species. The adult population size is probably less than 10,000 adults, and a decrease of 10% is expected during the next 10 years, due to more modern economic development, forest management and climate warming. Thus this species is listed as Vulnerable.

Reasons for Change

Nongenuine Change: New Information

Distribution

Geographic Range

Somatochlora borisi is a recently discovered species. Based on current knowledge of the species (Marinov 2001, Grebe *et al.* 2005, Boudot *et al.* 2004, Lopau 2005, Fleck *et al.* 2007) it is a strict endemic of the eastern Balkans occurring in the area that crosses the borders of Greece, Bulgaria and Turkey. All 17 known inhabited stream systems fall within a 13,750 km² area within both the Eastern Rhodopes and the northern and southern foot-slopes of the Istranca range, the latter being an eastern continuity of the Rhodopes range. This area has a hot and humid climate and has much forest cover, which is used both for wood production and traditional extensive rearing of goats and sheep. A number of valleys, when not planted with conifers, are well preserved and have a great entomological and botanical richness.

Elevation / Depth / Depth Zones

Elevation Lower Limit (in metres above sea level): 0

Elevation Upper Limit (in metres above sea level): 300

Biogeographic Realms

Biogeographic Realm: Palearctic

Occurrence

Countries of Occurrence

Country	Presence	Origin	Formerly Bred	Seasonality
Bulgaria	Extant	Native	-	Resident
Greece	Extant	Native	-	Resident
Greece -> Greece (mainland)	Extant	Native	-	Resident
Turkey	Extant	Native	-	Resident
Turkey -> Turkey-in-Europe	Extant	Native	-	Resident

Population

Seventeen stream systems are presently known to be inhabited by this species. Based on exuviae collections, counting and extrapolation during and after emergence of adults, the species seems relatively abundant in some places (100-500), and relatively reduced in others (less than 50). A rough extrapolation estimates less than 10,000 adults per year.

Habitats and Ecology

The main habitat are forest rivers at places with low current and below 300 m above sea level. Larvae are able to survive the drought summer period in disconnected residual pools in river beds. However, the species does not reproduce in standing water.

IUCN Habitats Classification Scheme

Habitat	Suitability	Major Importance?
Wetlands (inland) -> Wetlands (inland) - Permanent Rivers/Streams/Creeks (includes waterfalls)	Suitable	Yes
Wetlands (inland) -> Wetlands (inland) - Seasonal/Intermittent/Irregular Rivers/Streams /Creeks	Suitable	Yes

Systems

System: Terrestrial, Freshwater

Threats

Most of the forest areas where this species occurs are currently extensively used for traditional rearing of goats and sheep, which result in a number of clearing areas. However, intensive conifer plantations have been grown in the past and such monospecific forest areas seem to be unfavourable for *S. borisi*. Monospecific plantations of *Robinia pseudacacia* are now developed on abandoned agricultural fields, which may reduce the availability of maturation and foraging areas. Additional conifer plantations, water pollution and stream drying in relation to global warming and abnormal summer drought may be a threat for this species in the future. As early as end July 2008, Greek localities visited showed only disconnected residual pools with no flowing water at all. With drought periods increasing in intensity, length and frequency, the species is at risk of extinction.

Conservation

Necessary conservation actions are the control of water pollution, removal of conifer plantations and restoration of deciduous forests combined with the creation or maintenance of non-wooded sunny areas, particularly in the bottom of valleys. Conservation of clear riparian forests, traditionally induced by extensive rearing of goats and sheep, is required, as well as conservation of riverine trees. Two rivers inhabited by this species are included in the Greek national Dadia Protected Area buffer zone.

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Somatochlora borisi

NE DD LC NT VU VULNERABLE EN CR EW EX

range type

Native (resident)

national boundaries

subnational boundaries

lakes, rivers, canals

salt pans, intermittent rivers

gall stereographic central point: 0°, 0°

map created 02/05/2010

data source:
IUCN (International Union for Conservation of Nature)

0 1,920

kilometer

RED LIST

THE IUCN RED LIST OF THREATENED SPECIES™

The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

European Commission

European Red List of Dragonflies

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IUCN – The Species Survival Commission

The Species Survival Commission (SSC) is the largest of IUCN's six volunteer commissions with a global membership of 8,000 experts. SSC advises IUCN and its members on the wide range of technical and scientific aspects of species conservation and is dedicated to securing a future for biodiversity. SSC has significant input into the international agreements dealing with biodiversity conservation. www.iucn.org/ssc

IUCN – Species Programme

The IUCN Species Programme supports the activities of the IUCN Species Survival Commission and individual Specialist Groups, as well as implementing global species conservation initiatives. It is an integral part of the IUCN Secretariat and is managed from IUCN's international headquarters in Gland, Switzerland. The species Programme includes a number of technical units covering Species Trade and Use, The IUCN Red List, Freshwater Biodiversity Assessment Initiative (all located in Cambridge, UK), and the Global Biodiversity Assessment Initiative (located n Washington DC, USA). www.iucn.org/species

IUCN - Dragonfly Specialist Group

The IUCN Dragonfly Specialist Group focuses on the conservation of damselflies, dragonflies and their freshwater habitats. The DSG has a global volunteer network of over 50 expert members across the globe. Main focus of the work is the gathering and dissemination of information on distribution and threats of the nearly 6.000 damselflies and dragonflies. Currently the DSG is working on distribution databases and an assessment of the threat status of all damselflies and dragonflies. The Global Dragonfly Assessment will be an important tool in the conservation of freshwater habitats.

IUCN – Regional Office for Pan-Europe

The IUCN Regional Office for Pan-Europe and Permanent Representation to the European Union (ROfE) is based in Brussels, Belgium. Through its Programme Offices in Belgrade and Tbilisi and in cooperation with more than 350 European members and other parts of the IUCN constituency, the Regional Office for Pan-Europe implements the IUCN European Programme. The Programme area covers 55 countries and stretches from Greenland in the west to Kamchatka in the east. www.iucn.org/europe

The European Red List is a review of the conservation status of c. 6,000 European species (mammals, reptiles, amphibians, freshwater fishes, butterflies, dragonflies, and selected groups of beetles, molluscs, and vascular plants) according to IUCN regional Red Listing guidelines. It identifies those species that are threatened with extinction at the regional level – in order that appropriate conservation action can be taken to improve their status.

This publication summarises results for Europe's 137 native (sub)species of damselflies and dragonflies. Approximately one out of seven are threatened with extinction at the European level. One of the most important threats is the desiccation of their habitat due to the increasingly hot and dry summers combined with the intensified water extraction for drinking and irrigation.

The European Red List was compiled by IUCN's Species Programme, Species Survival Commission and Regional Office for Pan-Europe and is the product of a service contract with the European Commission. It is available online at http://ec.europa.eu/environment/nature/conservation/species/redlist and http://www.iucnredlist.org/europe

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