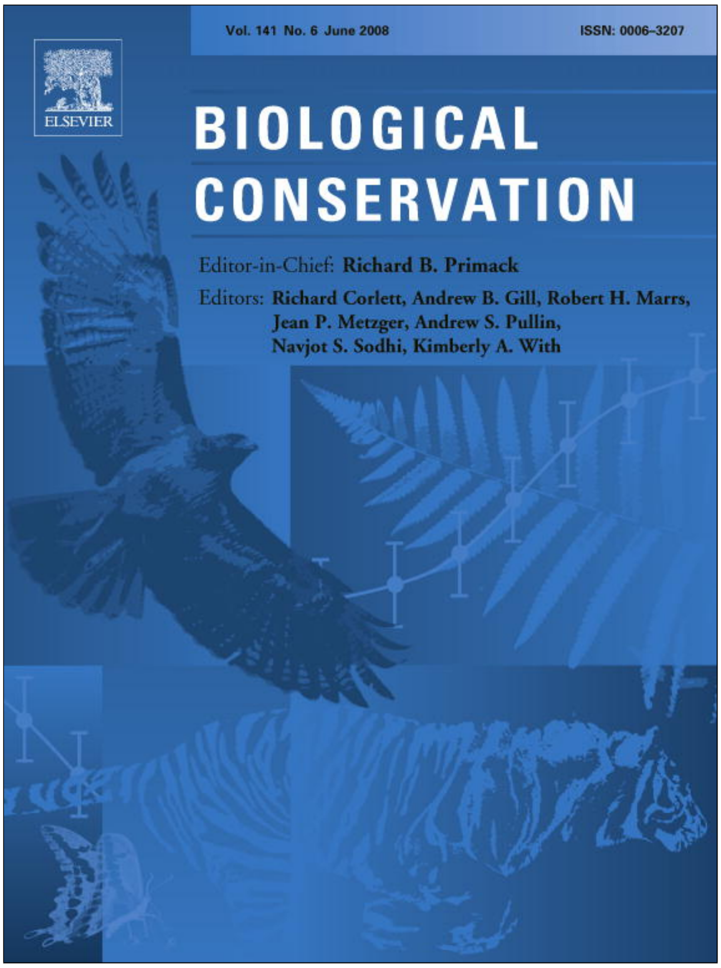
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Are the endemic water beetles of the Iberian Peninsula and the Balearic Islands effectively protected?

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ABSTRACT

One of the most serious environmental problems is the current acceleration in the rate of species extinction associated with human activities, which is occurring particularly rapidly in freshwaters. Here we examine whether endemic water beetles are effectively protected by existing conservation measures in the Iberian Peninsula and the Balearic Islands, a region of high diversity and intense human pressure. We used an exhaustive database for aquatic beetles in the region to address such issues. Firstly, we identify the most threatened endemic taxa using a categorization system to rank species according to their conservation priority or vulnerability. Of the 120 endemic species of water beetles used in the analysis, only two (*Ochthebius ferroi* and *Ochthebius javieri*) were identified as being extremely vulnerable, 71 were highly vulnerable and 46 moderately vulnerable, with only a single species identified as having low vulnerability status. Since no Iberian species of aquatic Coleoptera has legal protection, the only conservation measure available for these species is the extent to which they occur in protected areas. Here we identify distributional hotspots for threatened endemic species, and evaluate the extent to which these are already included in the Natura 2000 network in Spain and Portugal. Despite a high degree of concordance between hotspots and Natura 2000 sites, the distribution of four species falls completely outside the network. The analysis also reveals that Natura 2000 fails to protect saline water bodies, despite their high conservation interest and narrow global distribution. The picture revealed here with water beetles is likely to be similar for others groups of freshwater macroinvertebrates, since Coleoptera are known to be good surrogates of aquatic biodiversity in the region. Finally, the degree of protection provided via Natura 2000, and the utility of red lists are discussed.

1. Introduction

Nowadays, among the numerous environmental problems, one of the most serious is undoubtedly the acceleration in the rate of species extinction associated with human activities, as it involves an irreversible loss of biological information with unpredictable consequences (Wilson, 1988; May et al., 1995; Fontaine et al., 2007). Biodiversity is unevenly distributed, and some areas and groups contain most of this biological information. In this context, conservation efforts

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should be focussed on areas of high biodiversity, with the highest number of threatened species (Kerr et al., 2000; Margules and Pressey, 2000).

There is a widespread agreement that rates of biodiversity loss are greater in freshwater systems than in other ecosystems (Allan and Flecker, 1993; Master et al., 1998; Ricciardi and Rasmussen, 1999; Saunders et al., 2002; Darwall and Vié, 2005). Furthermore, human pressures on freshwater resources are likely to increase in the coming decades, putting yet more species at risk (Strayer, 2006). The most severe threat to freshwater species is habitat loss, followed by pollution and invasive species (IUCN, 2004). This can be particularly important in the Mediterranean Basin, which is considered as one of Earth's hotspot areas for biodiversity (Mittermeier et al., 1998; Myers et al., 2000) and where landscapes have been subject to strong human influence for millennia (Naveh and Lieberman, 1984). The transformation of agricultural landscapes, moving from extensive to intensive farming, has accelerated during this century, leading to the progressive loss of inland water habitats (Hollis, 1995; Stoate et al., 2001).

Here we use water beetles as an example of the wider freshwater biota since they are perhaps one of the best known groups of invertebrates, from a taxonomic and biogeographical perspective in the Iberian Peninsula and Balearic Islands (Ribera et al., 1998; Ribera, 2000). Water beetles also have high species richness in the Mediterranean region and inhabit virtually every kind of fresh- and brackish water habitat, from the smallest ponds to lagoons and wetlands and from streams to irrigation ditches and reservoirs (e.g. Ribera et al., 1998; Ribera, 2000; Millán et al., 2002). Furthermore, they have been shown to be good indicators of the wider biodiversity in aquatic ecosystems (Bilton et al., 2006; Sánchez-Fernández et al., 2006) and have been used successfully to select priority areas for conservation (Sánchez-Fernández et al., 2004a; Abellán et al., 2005).

The Iberian Peninsula and the Balearic Islands are areas of great biogeographic interest, being regarded as one of the richest European regions in terms of species diversity (Médail and Quézel, 1997; Domínguez-Lozano et al., 1996; Reyjol et al., 2007). Insects in general and beetles in particular, make up the highest percentage of the biodiversity of this area. Close to 98% of the total Iberian fauna are invertebrates, and roughly 81% are insects (Ramos et al., 2001). Iberian water beetles comprise 510 species and sub-species, 120 of which are endemic to the region. Few invertebrate species in the area have legal protection or are included in red lists. Only 10 species of water beetles are included in red lists at national or international level: *Acilius duvergeri* Gobert, 1874; *Cybister vulneratus* Klug, 1834; *Hydroporus lluci* (Fery, 1999); *Ochthebius glaber* Montes and Soler, 1988 and *Ochthebius montesi* Ferro, 1983 are included in the Red Book of Spanish invertebrates (Verdú and Galante, 2006) and *A. duvergeri* Gobert, 1874; *Ilybius hozgargantae* Burmeister, 1983; *Deronectes algibensis* Fery and Fresneda, 1988; *Deronectes depressicollis* (Rosenhauer, 1856); *D. ferrugineus* Fery and Brancucci, 1997 and *Rhithrodytes agnus agnus* Foster, 1993 are included in the IUCN Red List (IUCN, 2004). Since these were proposed, some changes have been suggested for the IUCN Red List. Abellán et al. (2005) proposed including *Ochthebius irenae* Ribera and Millán, 1998; *O. glaber* Montes and Soler, 1988 and *O. montesi* Ferro, 1983; and Ribera (2000) proposed the inclusion of *Rhithrodytes agnus argaensis* Bilton and Fery, 1996; *Stenelmis consobrina* Dufour, 1835 and *Potamophilus acuminatus* (Fabricius, 1792) and the exclusion of *I. hozgargantae* Burmeister, 1983; *D. depressicollis* (Rosenhauer, 1856); and *D. ferrugineus* Fery and Brancucci, 1997, which have recently been shown to be more widespread than formerly thought.

None of the Ibero–Balearic species of aquatic Coleoptera has legal protection, none being included in the National Catalogue of Threatened Species of Spain or Portugal, Annex II of the Bern convention or Annex II and IV of the Habitats Directive (92/43/EEC). Whilst the effectiveness of legal protection for small invertebrates may be debated (Hutchings and Ponder, 1999; New and Sands, 2003), in the current situation, the only protection available to these species is the extent to which they occur in protected areas designated on the basis of other taxa or habitat features. Most protected areas networks have been designated based on selected target species, or group of target organisms (typically plants and vertebrates). Such a strategy for establishing nature reserves may frequently lead to an under-representation of many important components of biodiversity (Linnell et al., 2000), suggesting than that reserves are not always suited to protect 'non charismatic' organisms (Kati et al., 2003; Martínez et al., 2006). Consequently, it is necessary to evaluate the effectiveness of existing reserve networks (such as Natura 2000) in protecting threatened, diverse and 'non charismatic' groups, such as water beetles. Despite these requirements, very few assessments of the effectiveness of protected area networks in maintaining any aspect of freshwater biodiversity have been carried out (e.g. Keith, 2000; Abellán et al., 2006), despite the fact that species losses in these habitats are alarmingly high.

The work presented here aims to determine the extent to which endemic Iberian and Balearic water beetles are protected by existing conservation networks. As discussed above, aquatic Coleoptera are good surrogates of inland water biodiversity, so patterns which hold for this group are likely to apply to other aquatic taxa. The study has three specific objectives: (1) to identify the most threatened endemic water beetles in the study area, by ranking species according to their conservation priority or degree of vulnerability; (2) to locate distributional hotspots for the most threatened species; and (3) to evaluate the extent to which the Natura 2000 network provides effective protection for these species and areas.

2. Materials and methods

2.1. Study area

The study focuses on the Iberian Peninsula and Balearic Islands, two close, bio-geographically related areas (López-Martínez, 1989) which extend over 585,644 km^2 (Fig. 1). The territory includes a variety of biomes, relief, climates, and soil types, where altitude ranges from sea level to 3483 m in the Sierra Nevada. Although being entirely within the temperate zone, the rugged topography of the Iberian region gives rise to a great diversity of climates, from semiarid Mediterranean, to oceanic in the northern fringes, and alpine in the high mountains. The study area is one of the richest European

Fig. 1 – Study area, showing key locations referred to in the text.

regions in terms of animal species diversity (Williams et al., 2000), and particularly in endemic water beetles (Ribera, 2000; Ribera et al., 2003) and is characterised by wide range of ecosystem types, some of which are rare on a European scale.

All major inland aquatic habitat types are present within the Ibero–Balearic area, and here we divide inland waters into the following: headwater streams, rivers and middle reach streams, saline streams, springs, irrigation channels, rice-fields, artificial pools, reservoirs, lagoons, pools and ponds, and salt-pans (Millán et al., 2002; Sánchez-Fernández et al., 2004a).

2.2. *Data set*

We used an exhaustive database of records of Iberian water beetles (ESACIB) to assess the status and degree of protection afforded to endemic species in the area. This database almost certainly represents the most complete information available for a major group of freshwater invertebrates in the study area. ESACIB includes all available geographical and biological data from the literature up to 2006, as well as from museum and private collections, doctoral theses, and other unpublished sources. The database contains over 50,000 records with associated location data (10×10 UTM squares) for 510 species of water beetles. ESACIB also contains information on abundance, habitat and date of last record for Iberian endemic species.

We concentrated on the 120 species and well established sub-species of water beetle endemics of the Iberian Peninsula and Balearic Islands. We selected this subset to be able to assess degree of vulnerability in absolute terms, due to our understanding of their distribution throughout their ranges. In total more than 6500 records (species/site/reference, with associated information on persistence, abundance and habitat type) were included in analyses.

2.3. *Assessing conservation status of taxa*

IUCN categories of threat (Endangered, Vulnerable, Rare, Indeterminate, etc.) are widely used in Red lists of endangered species, and have become an important tool in conservation action at international, national and regional levels. Existing definitions are largely subjective, however, and as a result evaluations made by different authors frequently differ, and may not accurately reflect actual extinction risk (Mace and Lande, 1991; Abellán et al., 2005; Fitzpatrick et al., 2007). Furthermore, for many groups most species would have to be classified as data-deficient and, in the case of most invertebrates, where good quality historical or demographic data are lacking, it is inconceivable that there will ever be sufficient data for a sensible classification based on current IUCN evaluation techniques (Sutherland, 2000). As a consequence there remains a need for alternative objective methods with which to assess species' vulnerability, particularly ones that are applicable to invertebrates. Here we applied a method for prioritizing species and populations for conservation developed by Abellán et al. (2005), modifying some the scoring of some variables. This evaluation is based on a set of six species and habitat attributes: general distribution, Iberian distribution, rarity, persistence, habitat rarity and habitat loss. Each variable was scored 0–3 for each species, in order of increasing perceived risk (see Table 1). Variables were categorized and evaluated as follows:

1. General distribution. Five types of general distributional range (GD) were distinguished, from trans-Iberian to endemic (see Table 1 for more details). The highest scores are assigned to species with the most restricted ranges. In our case, all species score 3 because all are endemic species, but this variable was maintained in order to keep the structure of the original methodology and to be able to compare absolute scores with future assessment of non endemic species.
2. Iberian distribution (ID). Here we overlapped the actual distribution of species with the bio-geographical regions defined by Ribera (2000), including the Balearic Islands as an additional region. Species' scores were based on the number of regions occupied, the highest scores being given to species restricted to a single region.
3. We evaluated Rarity (R) as a combination of three different aspects of rarity: rarity of occupancy (number of sites occupied), rarity of individuals within areas (density rarity), and habitat specificity (Rabinowitz et al., 1986; Gaston, 1994; see Table 1).
4. We evaluated the persistence (P) of a species as its temporal continuity in the study area (Abellán et al., 2005). This was determined from the date of the last record (see Table 1).
5. Habitat rarity (HR) was considered since species restricted to locally scarce habitats are likely to be more vulnerable to local extinction. This was evaluated using an expert panel (see below).
6. Habitat loss (HL). This variable is also important as species that were once widespread can become rare or vulnerable through habitat loss (HL) or fragmentation. This was also evaluated using an expert panel.

In the absence of an obvious quantitative way to evaluate the last two variables, we instead relied upon an "expert panel". Surveys were sent to researchers working on freshwater ecosystems in the Iberian Peninsula including a wide range of workers to minimize local subjectivity. Individual researchers were asked to score the major inland aquatic habitat types (see above) according to their perception of their rarity, and the degree to which they are under threat within the Ibero–Balearic area. Scores (rarity/threat) ranged from 0 to 3, where 0 was very common/not threatened, 1 moderately common/minimally threatened, 2 moderately rare/threatened and 3 extremely rare/very threatened. We calculated the mean value of rarity and threat for each habitat type on the basis of the twenty-four returned sets of scores. Results from this expert panel are show in Table 2. We multiplied the rarity or threat scores of each habitat by the percentage occurrence of each species in each habitat to produce a habitat rarity (HR) score for each species. Values were then ranked into four categories, scored from 0 to 3.

We grouped species into four vulnerability categories according to their overall vulnerability scores: low (0–4); moderate (5–8); high (9–13); very high (14–18), following Abellán et al. (2005). Species assigned to high and very high categories were considered high-priority taxa in conservation terms.

Distribution maps of all these high-priority conservation species were overlapped to detect 'hotspots' of threatened endemic water beetles: these being defined as cells containing a record of at least three of those species.

2.4. Gap analysis and effectiveness assessment

The Natura 2000 network forms the core of measures to protect biodiversity in Europe. Under the EC Habitats Directive (EU Council Directive 92/43/EEC), Member States are required to prepare, and propose to the European Commission, a national list of sites of community importance (pSCIs). These will eventually be designated by the Member States as special areas of conservation (SACs) (Article 4.4). These SACs, together with Special Protection Areas (SPAs) designated under the Birds Directive (79/409/EEC), will collectively form the

Table 1 – Variables used in species vulnerability analysis, and their rank values

Variables	Score			
	0	1	2	3
General distribution (GD)	Trans-Iberian species	Northern and Southern	Disjunct species	Endemic species
Iberian distribution (ID)	Presence in 4 or more bio-geographical regions	Presence in 3 bio-geographical regions	Presence in 2 bio-geographical regions	Presence in 1 bio-geographical region
Rarity (R)	None of the 3 criteria exposed below	One of the criteria exposed below	Any two of the criteria exposed below	All the criteria
	gr (geographic rarity)	Small range size (less than 20 squares)		
	dr (demographic rarity)	Low abundance (less than 10 exemplars)		
	hs (habitat Specificity)	High habitat specificity (more than 75% of total records in one habitat type)		
Persistence (P)	Last capture after 2001	Last capture between 1997 and 2001 (last 10 years)	Last capture between 1996 and 1987 (last 20 years)	Last capture before 1987 (more than 20 years)
Habitat rarity (HR)	Rarity values of habitat type < 0.75	Rarity values of habitat type between 0.75 and 1.5	Rarity values of habitat type between 1.6 and 2.25	Rarity values of habitat type > 2.25
Habitat loss (HL)	Habitat loss values < 0.75	Habitat loss values between 0.75 and 1.5	Habitat loss values between 1.6 and 2.25	Habitat loss values > 2.25

Table 2 – Rarity and threat scores for habitat types in the study area, according to the expert panel

Habitat type	Rarity	Threat
Irrigation channels	0	0
Headwater streams	0	1
Rice-fields	2	1
Artificial pool	0	0
Reservoir	0	0
Spring	1	2
Lagoons	2	2
Pools, ponds	1	2
Saline streams	3	2
Rivers and middle reach streams	0	3
Salt-pans	2	2

future Natura 2000 network (Article 3.1 of the Habitats Directive). Four GIS data layers (SACs and SPAs for Spain and Portugal) supplied by national conservation agencies, were edited and combined to produce a single layer of current Natura 2000 networks areas in the Iberian Peninsula and the Balearics.

We conducted a gap analysis to evaluate the degree of protection of the high-priority species and hotspots achieved by the Natura 2000 network in the study area by overlapping the distribution maps of individual species and hotspots with the Natura 2000 network map using Arcview 3.2 (ESRI Inc.). Here a square is considered protected when at least 25% of its area is within a Natura 2000 site. This threshold was considered appropriate since most aquatic habitats are highly influenced by processes occurring in their catchments.

3. Results

3.1. Identification of threatened species

Of the 120 endemic species of water beetles used in the analysis, only two (1.7%) were identified as being of very high vulnerability, 71 (59.2%) were identified as high vulnerability, 46 taxa (38.3%) as moderate, and a single remaining species (0.8%) was assigned low vulnerability status (Table 3). As a result of these rankings, we were able to identify 73 high-priority species among Iberian Peninsula and Balearic Island endemics (with a vulnerability score of 9 or above).

The two most endangered species in the region (identified as of very high vulnerability) are both known only from their type series. They are *Ochthebius ferroi* and *Ochthebius javieri* (Hydraenidae). The former has not been recorded since its discovery in 1985 in a small spring located in the pre-Pyrenees (Betesa, Aragón), and the latter is a species found only once in a slightly brackish pond, a threatened habitat, at Cabo de Favàritx in Menorca (Balearic Islands).

Other than the obvious cases of extremely rare species, as those noted above, most of the high-priority species fall into two main groups: one includes those taxa that occur in habitats which are under immediate threat, and have high vulnerability scores as a consequence, despite being relatively widespread in the Iberian Peninsula (usually being found in more than 20 squares). This is the case with species inhabiting saline streams (e.g. *Nebrioporus baeticus*, *O. glaber*, *O. delgadoi*, *O. tudmirensis*) or rivers and middle reach streams (e.g. *Oulimnius bertrandi*). A second large group, is composed of species known from few localities which occur in habitats not under obvious immediate threat, usually located in headwater streams (e.g. *Hydraena isabelae*, *Hydraena mecai*, *Hydraena zezerensis*, *Ochthebius albacetinus*, *Ochthebius cantabricus*, *Agabus picotae*, *Deronectes brannani*) or more rarely in lagoons or ponds in mountainous areas (e.g. *Agabus nevadensis*, *Helophorus leontis*).

3.2. Habitat rarity and threats

According to the results of the expert query, the rarest habitats in the study area were saline streams followed by rice-fields, lagoons and salt-pans. The most threatened habitats were rivers and middle reach streams, followed by a group composed of springs, lagoons, pools and ponds, saline streams and salt-pans. On other hand, with the exception of rice-fields and salt-pans, both of have a long history in the region, no artificial habitats are rare or threatened (Table 2).

Spearman correlations were used to evaluate the relationship between the final vulnerability score and the variables used in the assessment of vulnerability. Vulnerability scores were determined principally by rarity (R) ($r = 0.76$, $p < 0.01$) and Iberian distribution (ID) ($r = 0.72$, $p < 0.01$). The vulnerability scores were not correlated with habitat loss (HL), probably due to the high number of restricted endemic species locates in headwater streams in mountainous areas, a habitat not considered under immediate threat. Furthermore, several of the species with low and moderate vulnerability appear in threatened habitats.

3.3. Hotspots of high-priority species

We identified 57 squares as hotspots of high-priority species (see Fig. 2). Thirty of these represent saline systems mainly located in the southern half of the Iberian Peninsula. Hotspots with the highest number of high-priority species (five species and above) contain taxa with narrow distributional ranges, typically in headwater streams or lagoons in mountain areas. Key areas (see Fig. 1) include: (1) Sierra de Guadarrama (Central Spain), with *Helophorus hispanicus*, *H. leontis*, *Helophorus nevadensis*, *Hydrochus interruptus* and *Limnebius montanus*; (2) Sierra de Alcaráz (SE Spain), with *H. mecai*, *Hydraena servilia*, *Limnebius millani*, *O. albacetinus* and *O. semotus*; (3) Sierra Nevada (S Spain) with a total of eight high-priority species in two adjacent squares, four of them restricted to the Sierra Nevada itself (*A. nevadensis*, *Hydroporus sabaudus sierranevadensis*, *Hydroporus normandi alhambrae*, *Limnebius monfortei*); (4) Rambla Salada in Murcia (SE Spain), with five high-priority species found in a single saline stream system: *O. montesi*, *O. glaber*, *O. tudmirensis*, *O. delgadoi* and *N. baeticus*. Remaining hotspots have fewer species, but again include species with narrow distributional ranges, and are mainly located in headwater streams from a range of Iberian regions such as Serra de Arga, Los Alcornocales, Serra da Estrela, Pre-Pyrenees, Sierra Morena, Sierra de Cazorla and Cordillera Cantabrica (see Fig. 1).

Table 3 – Vulnerability scores of variables used in vulnerability assessment

Code	GD	ID	dr	gr	hs	R	P	HR	HL	SV	CAT
Och.ferr	3	3	1	1	1	3	3	1	2	15	Very high
Och.javi	3	3	1	1	1	3	2	1	2	14	Very high
Och.anda	3	3	0	1	1	2	0	3	2	13	High
Och.caes	3	3	0	1	1	2	0	3	2	13	High
Och.mont	3	3	0	1	1	2	0	3	2	13	High
Aga.neva	3	3	0	1	1	2	0	2	2	12	High
Hdn.luca	3	3	1	1	1	3	0	0	3	12	High
Hdn.quet	3	3	1	1	1	3	0	0	3	12	High
Hep.joco	3	2	1	1	0	2	2	0	3	12	High
Hep.koro	3	3	0	1	0	1	2	1	2	12	High
Hyd.sier	3	3	0	1	1	2	0	2	2	12	High
Lib.hila	3	3	0	1	1	2	1	0	3	12	High
Och.cant	3	3	0	1	1	2	3	0	1	12	High
Hdn.alca	3	3	1	1	0	2	1	0	2	11	High
Hdn.alta	3	3	0	1	1	2	0	0	3	11	High
Hdn.mari	3	3	1	1	1	3	0	0	2	11	High
Hep.leon	3	2	1	1	1	3	0	1	2	11	High
Lib.mino	3	3	0	1	1	2	2	0	1	11	High
Lib.ordu	3	3	0	1	1	2	0	0	3	11	High
Neb.croc	3	3	0	1	0	1	1	0	3	11	High
Och.alba	3	3	0	1	1	2	2	0	1	11	High
Och.diaz	3	3	1	1	1	3	1	0	1	11	High
Och.glab	3	2	0	0	1	1	0	3	2	11	High
Och.pedr	3	3	1	1	0	2	2	0	1	11	High
Och.tudm	3	2	0	0	1	1	0	3	2	11	High
Ibe.cerm	3	3	0	1	1	2	0	1	2	11	High
Aga.pico	3	3	0	1	1	2	1	0	1	10	High
Der.cosg	3	3	0	1	0	1	1	0	2	10	High
Der.fost	3	3	0	1	1	2	1	0	1	10	High
Dry.cham	3	3	1	1	0	2	0	0	2	10	High
Hch.inte	3	3	1	1	0	2	0	0	2	10	High
Hdn.alba	3	3	1	1	0	2	0	0	2	10	High
Hdn.isab	3	3	1	1	1	3	0	0	1	10	High
Hdn.lusi	3	3	1	1	0	2	0	0	2	10	High
Hdn.meca	3	3	1	1	1	3	0	0	1	10	High
Hdn.serv	3	3	1	1	0	2	0	0	2	10	High
Hdn.zeze	3	3	1	1	1	3	0	0	1	10	High
Hep.hisp	3	3	1	1	0	2	0	0	2	10	High
Hyt.fres	3	3	0	1	0	1	0	1	2	10	High
Lib.igna	3	3	0	1	0	1	0	0	3	10	High
Lib.mill	3	3	1	1	1	3	0	0	1	10	High
Lib.monf	3	3	1	1	0	2	0	0	2	10	High
Neb.baet	3	1	0	0	1	1	0	3	2	10	High
Och.gayo	3	3	0	1	0	1	1	0	2	10	High
Och.iren	3	2	0	1	0	1	0	2	2	10	High
Och.semo	3	3	1	1	0	2	0	0	2	10	High
Der.algi	3	3	0	1	1	2	0	0	1	9	High
Der.aube	3	2	0	1	0	1	1	0	2	9	High
Der.bran	3	3	0	1	1	2	0	0	1	9	High
Der.wewa	3	3	0	1	1	2	0	0	1	9	High
Hch.angi	3	2	1	1	0	2	0	0	2	9	High
Hdn.cata	3	3	0	1	0	1	0	0	2	9	High
Hdn.deli	3	3	0	1	1	2	0	0	1	9	High
Hdn.gadi	3	3	0	1	0	1	0	0	2	9	High
Hdn.madr	3	3	0	1	1	2	0	0	1	9	High
Hdn.marc	3	3	0	1	0	1	0	0	2	9	High
Hdn.mons	3	3	0	1	0	1	0	0	2	9	High
Hdn.tati	3	3	0	1	0	1	0	0	2	9	High
Hep.neva	3	2	0	1	0	1	1	0	2	9	High
Hyd.alha	3	3	0	1	1	2	0	0	1	9	High
Hyd.cant	3	3	0	1	0	1	0	0	2	9	High
Hyd.cons	3	3	0	1	0	1	0	0	2	9	High
Hyd.lluc	3	3	1	1	0	2	0	0	1	9	High

(continued on next page)

Table 3 – *continued*

Code	GD	ID	dr	gr	hs	R	P	HR	HL	SV	CAT
Ily.dett	3	3	0	1	0	1	0	0	2	9	High
Lab.glor	3	2	1	1	0	2	0	0	2	9	High
Lib.mont	3	3	0	1	0	1	0	0	2	9	High
Lib.nanu	3	3	0	1	0	1	1	0	1	9	High
Och.delg	3	1	0	0	0	0	0	3	2	9	High
Oul.bert	3	2	0	0	1	1	0	0	3	9	High
Oul.echi	3	3	0	1	1	2	0	0	1	9	High
Rhi.agnu	3	3	0	1	1	2	0	0	1	9	High
Rhi.arga	3	3	0	1	1	2	0	0	1	9	High
Rhi.bima	3	2	1	1	1	3	0	0	1	9	High
Der.angu	3	2	0	1	0	1	0	0	2	8	Moderate
Der.cost	3	2	0	1	1	2	0	0	1	8	Moderate
Der.dela	3	3	0	0	0	0	0	0	2	8	Moderate
Der.depr	3	3	0	0	1	1	0	0	1	8	Moderate
Hdn.bale	3	3	0	1	0	1	0	0	1	8	Moderate
Hdn.boli	3	2	0	1	0	1	0	0	2	8	Moderate
Hdn.gava	3	3	0	1	0	1	0	0	1	8	Moderate
Hdn.iber	3	2	0	0	0	0	0	0	3	8	Moderate
Hdn.manf	3	2	0	1	1	2	0	0	1	8	Moderate
Hep.bame	3	1	0	1	0	1	0	1	2	8	Moderate
Hyd.brac	3	2	0	1	0	1	0	0	2	8	Moderate
Hyd.gred	3	3	0	1	0	1	0	0	1	8	Moderate
Hyd.paga	3	2	0	1	0	1	0	0	2	8	Moderate
Och.bell	3	2	0	1	1	2	0	0	1	8	Moderate
Oul.cyne	3	2	0	1	0	1	0	0	2	8	Moderate
Stn.occi	3	2	0	0	0	0	0	0	3	8	Moderate
Der.bico	3	2	0	0	0	0	0	0	2	7	Moderate
Der.ferr	3	2	0	0	0	0	0	0	2	7	Moderate
Grt.cast	3	1	0	0	0	0	0	1	2	7	Moderate
Hch.iber	3	2	0	1	0	1	0	0	1	7	Moderate
Hch.noor	3	2	0	0	1	1	0	0	1	7	Moderate
Hdn.hisp	3	2	0	0	0	0	0	0	2	7	Moderate
Hyd.bran	3	2	0	0	0	0	0	0	2	7	Moderate
Hyd.neco	3	1	0	0	0	0	0	1	2	7	Moderate
Hyd.vesp	3	1	0	0	0	0	0	1	2	7	Moderate
Lib.hisp	3	2	0	0	0	0	0	0	2	7	Moderate
Lib.iber	3	1	0	1	1	2	0	0	1	7	Moderate
Lib.lusi	3	2	0	0	0	0	0	0	2	7	Moderate
Neb.fabr	3	2	0	0	0	0	0	0	2	7	Moderate
Och.heyd	3	2	0	0	0	0	0	0	2	7	Moderate
Stt.bert	3	2	0	0	0	0	0	0	2	7	Moderate
Hdn.cori	3	1	0	0	0	0	0	0	2	6	Moderate
Hdn.shar	3	1	0	0	0	0	0	0	2	6	Moderate
Hyd.norm	3	0	0	0	0	0	0	1	2	6	Moderate
Hyd.vage	3	0	0	0	0	0	0	1	2	6	Moderate
Lib.cord	3	1	0	0	0	0	0	0	2	6	Moderate
Lin.perc	3	1	0	0	0	0	0	0	2	6	Moderate
Neb.buch	3	1	0	0	1	1	0	0	1	6	Moderate
Neb.cari	3	1	0	0	0	0	0	0	2	6	Moderate
Stt.iber	3	0	0	0	0	0	0	1	2	6	Moderate
Hdn.afus	3	0	0	0	0	0	0	0	2	5	Moderate
Hdn.unca	3	0	0	0	0	0	0	0	2	5	Moderate
Hep.seid	3	0	0	0	0	0	0	0	2	5	Moderate
Hyd.neva	3	0	0	0	0	0	0	0	2	5	Moderate
Lib.gerh	3	0	0	0	0	0	0	0	2	5	Moderate
Oul.tubp	3	0	0	0	0	0	0	0	2	5	Moderate
Hyd.deci	3	0	0	0	0	0	0	0	1	4	Low

(GD, general distribution; ID, Iberian distribution; gr (geographic rarity); dr (demographic rarity); hs (habitat specificity), rarity; P, persistence; HR, habitat rarity; HL, habitat loss; VS: vulnerability score; CAT: Category). See Appendix for species codes.

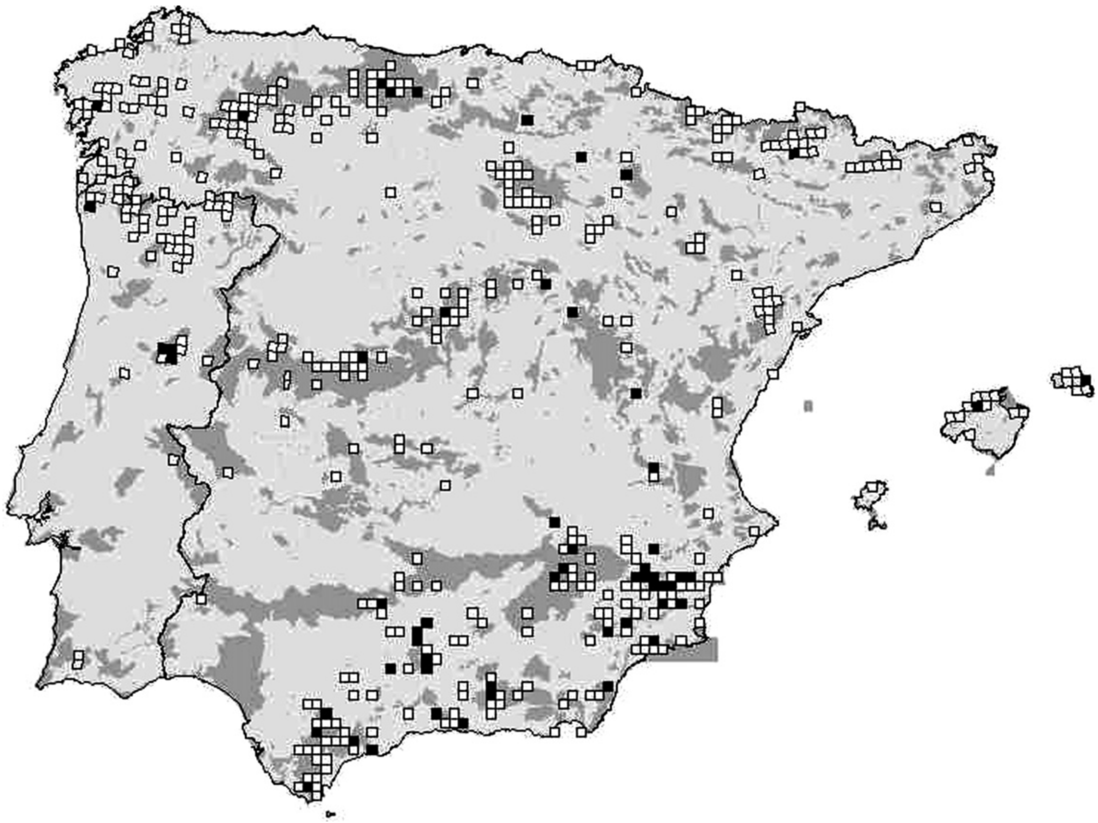

Fig. 2 – Location of the 57 squares recognized as hotspots of high-priority species (black) and remaining squares with high-priority species (white). Shaded surface represents the existing Natura 2000 network in the Iberian Peninsula and the Balearic Islands.

3.4. *Gap analysis*

When the distribution maps of individual species were superimposed on the Natura 2000 network map, a high degree of overlap was detected (Fig. 2 and Table 4), with the distributions of 22 species overlapping completely. These species occur mainly in mountainous areas, including the two species designed as having highest vulnerability. On the other hand, the distribution of four species is totally outside the existing Natura 2000 network. These species are *Iberoporus cermenius, Hydraena quetiae*, *L. monfortei* and *O. irenae*. Another nine species, including a number of predominantly lowland taxa and some associated with saline systems (*Hydrochus angusi*, *Hydraena alcantarana*, *Hydraena lucasi*, *N. baeticus, Ochthebius anadalusicus*, *O. delgadoi*, *O. glaber*, *O. tudmirensis* and *O. bertrandi*), have less than 40% of their distribution in protected areas.

If a square is considered protected when at least 25% of its surface area is included, then 56.66% of squares with high-priority species, and 52.63% of hotspots are included in the existing Natura 2000 network. If we consider a square as protected only when at least 50% is within Natura 2000, then these percentages are clearly lower, being 43.12% and 38.60%, respectively. In fact, 26 of the 57 hotspots are outside the Natura 2000 network, six of them completely, even if one uses a 1% overlap as a threshold for inclusion. All of these 'missing' hotspots were in lowland areas, with saline streams or salt-pans as their main aquatic ecosystem type (Fig. 3).

4. Discussion

These analyses allow us to prioritise endemic species of Iberian water beetle for conservation status, as well as to assess the effectiveness of the existing Natura 2000 network. In this context it is important to re-iterate that water beetles have been identified as excellent surrogates of inland water biodiversity in general (Bilton et al., 2006; Sánchez-Fernández et al., 2006) and that the results from this study are likely to be reflected in other less well-known groups of freshwater macroinvertebrates, for which we may never have adequate data to conduct the kind of analyses presented here. The key findings of this study are now discussed in turn, starting with potential implications for red list inclusion.

4.1. *Threatened water beetles and red Lists*

Most of the high-priority endemic species identified appear in headwater streams, illustrating the importance of isolation and speciation in montane lotic systems in generating much of the endemic water beetle diversity in the regions (Ribera and Vogler, 2004). Whilst such species are not usually under obvious proximate threat, their rarity makes them vulnerable, particularly in the face of anthropogenic climate change, which may impact such taxa directly, and through a reduction in the volume of available habitat (Wilson et al., 2005; Calosi et al., 2007). A special case could be the Balearic

Table 4 – Percentage of overlap between distribution maps of high-priority species and the Natura 2000 network

Code	N	1%	10%	25%	50%	75%	100%
Hyt.fres	10	90.00	80.00	70.00	70.00	40.00	10.00
Hyd.cant	2	100.00	100.00	100.00	100.00	50.00	50.00
Hyd.cons	6	100.00	100.00	100.00	100.00	83.30	66.70
Hyd.lluc	4	100.00	100.00	75.00	75.00	0.00	0.00
Hyd.alha	5	100.00	80.00	80.00	60.00	60.00	40.00
Hyd.sier	6	100.00	100.00	83.30	83.30	66.70	33.30
Ibe.cerm	1	100.00	100.00	0.00	0.00	0.00	0.00
Rhi.agnu	3	100.00	100.00	66.70	33.30	33.30	0.00
Rhi.arga	2	100.00	100.00	50.00	0.00	0.00	0.00
Rhi.bima	11	100.00	81.80	81.80	81.80	72.70	72.70
Der.algi	11	100.00	90.90	90.90	63.60	45.50	45.50
Der.aube	16	100.00	100.00	87.50	87.50	62.50	62.50
Der.bran	7	100.00	85.70	71.40	28.60	0.00	0.00
Der.cosg	18	100.00	100.00	94.40	88.90	77.80	55.60
Der.fost	7	85.70	85.70	71.40	0.00	0.00	0.00
Der.wewa	13	92.30	92.30	92.30	84.60	69.20	15.40
Neb.croc	1	100.00	100.00	100.00	0.00	0.00	0.00
Neb.baet	57	80.70	52.60	28.10	17.50	8.80	1.80
Aga.neva	2	100.00	100.00	100.00	100.00	100.00	50.00
Aga.pico	2	100.00	100.00	100.00	100.00	50.00	0.00
Ily.dett	9	66.70	66.70	66.70	44.40	44.40	22.20
Hep.hisp	3	100.00	100.00	100.00	100.00	100.00	0.00
Hep.koro	1	100.00	100.00	100.00	100.00	100.00	100.00
Hep.leon	6	83.30	83.30	66.70	50.00	50.00	16.70
Hep.neva	6	100.00	83.30	83.30	83.30	83.30	33.30
Hep.joco	5	100.00	80.00	80.00	60.00	40.00	0.00
Hch.angi	16	68.80	50.00	31.30	31.30	12.50	6.30
Hch.inte	10	100.00	70.00	50.00	40.00	20.00	0.00
Lab.glor	7	100.00	85.70	71.40	14.30	0.00	0.00
Hdn.cata	8	87.50	75.00	62.50	50.00	37.50	0.00
Hdn.gadi	5	80.00	80.00	80.00	80.00	40.00	0.00
Hdn.lusi	8	62.50	62.50	62.50	62.50	50.00	25.00
Hdn.madr	1	100.00	100.00	100.00	100.00	100.00	100.00
Hdn.mons	8	100.00	87.50	87.50	87.50	75.00	50.00
Hdn.tati	6	100.00	83.30	66.70	33.30	16.70	0.00
Hdn.zeze	1	100.00	100.00	100.00	100.00	100.00	0.00
Hdn.alba	4	100.00	100.00	100.00	50.00	25.00	0.00
Hdn.alca	4	100.00	50.00	25.00	25.00	25.00	0.00
Hdn.alta	3	66.70	66.70	66.70	66.70	66.70	0.00
Hdn.deli	13	100.00	84.60	69.20	61.50	23.10	0.00
Hdn.isab	3	100.00	100.00	66.70	66.70	66.70	33.30
Hdn.luca	6	100.00	33.30	33.30	33.30	16.70	0.00
Hdn.marc	6	100.00	100.00	100.00	100.00	83.30	33.30
Hdn.mari	5	80.00	80.00	60.00	40.00	40.00	0.00
Hdn.meca	1	100.00	100.00	100.00	100.00	100.00	100.00
Hdn.quet	1	100.00	0.00	0.00	0.00	0.00	0.00
Hdn.serv	18	100.00	83.30	77.80	72.20	66.70	50.00
Lib.hila	3	100.00	100.00	66.70	33.30	33.30	0.00
Lib.igna	10	100.00	90.00	70.00	60.00	40.00	0.00
Lib.mill	2	100.00	100.00	100.00	100.00	100.00	50.00
Lib.mino	2	100.00	100.00	100.00	100.00	0.00	0.00
Lib.monf	1	100.00	100.00	0.00	0.00	0.00	0.00
Lib.mont	13	100.00	92.30	92.30	76.90	76.90	30.80
Lib.nanu	3	100.00	100.00	100.00	66.70	33.30	33.30
Lib.ordu	3	100.00	100.00	100.00	66.70	33.30	33.30
Och.cant	1	100.00	100.00	100.00	100.00	100.00	100.00
Och.ferr	1	100.00	100.00	100.00	100.00	100.00	0.00
Och.iren	5	100.00	20.00	0.00	0.00	0.00	0.00
Och.alba	4	100.00	100.00	100.00	75.00	75.00	75.00
Och.anda	6	83.30	66.70	33.30	33.30	16.70	0.00
Och.caes	6	83.30	66.70	66.70	33.30	16.70	0.00
Och.delg	62	90.30	67.70	35.50	25.80	12.90	6.50
Och.diaz	1	100.00	100.00	100.00	100.00	100.00	100.00
Och.gayo	3	66.70	66.70	66.70	33.30	0.00	0.00

Table 4 – continued

Code	N	1%	10%	25%	50%	75%	100%
Och.glab	20	65.00	45.00	35.00	15.00	0.00	0.00
Och.javi	1	100.00	100.00	100.00	100.00	0.00	0.00
Och.mont	8	100.00	100.00	50.00	37.50	12.50	0.00
Och.pedr	2	100.00	100.00	50.00	50.00	0.00	0.00
Och.semo	10	90.00	90.00	80.00	60.00	50.00	30.00
Och.tudm	25	92.00	68.00	28.00	20.00	4.00	4.00
Oul.bert	89	61.80	48.30	37.10	31.50	20.20	6.70
Oul.echi	10	100.00	90.00	60.00	30.00	0.00	0.00
Dry.cham	7	100.00	100.00	85.70	71.40	57.10	14.30
Hotspots	57	89.47	75.44	52.63	38.60	28.07	14.04
Non Hotspot	386	83.16	69.95	57.25	43.78	30.57	14.77
Total	443	83.97	70.65	56.66	43.12	30.25	14.67

Different thresholds (1%, 25%, 50%, 75% and 100%) are used to consider a square as protected. See Appendix for species codes. (N: Number of squares with records for given species.)

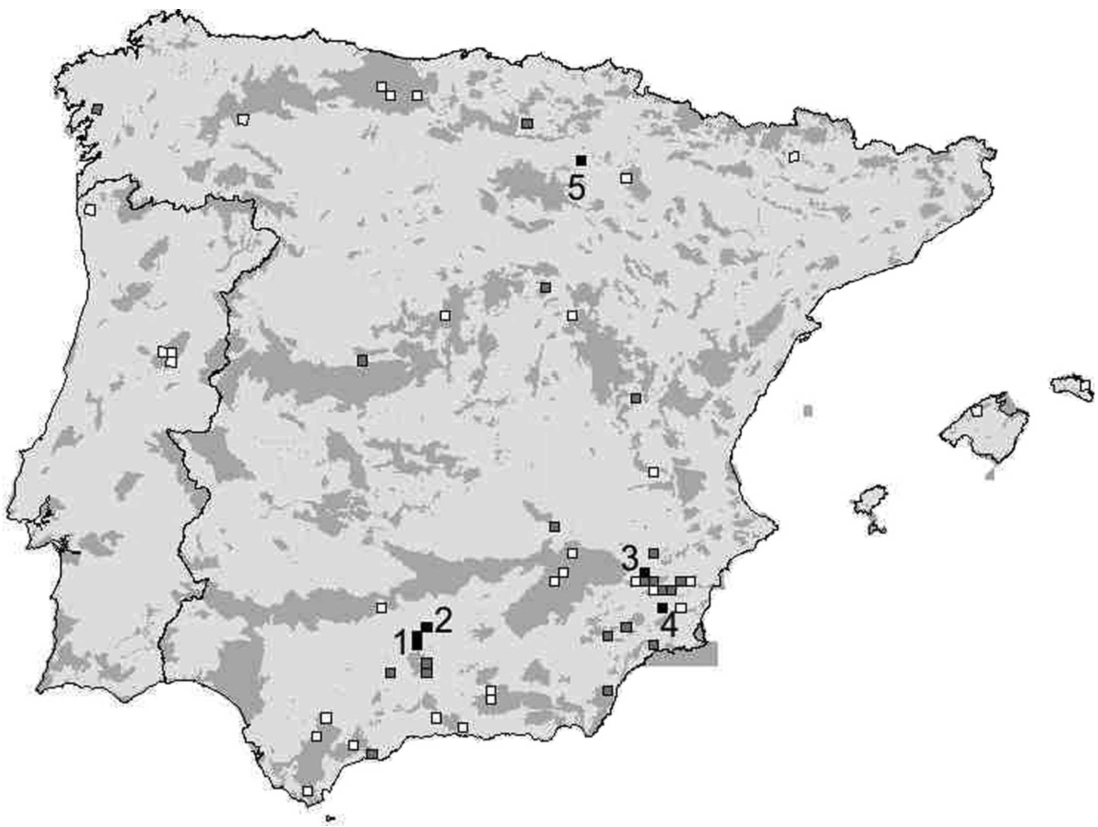

Fig. 3 – Location of protected hotspots of high-priority species (white); hotspots that are outside the Natura 2000 network (considering 25% surface as threshold for inclusion) (grey) and the 6 squares recognized as hotspots of high-priority species entirely outside the Natura 2000 network (1% of threshold) (black). (1: salt-pans and saline streams in La Maturra; 2: salt-pans and saline streams in Porcuna; 3: Rambla of Aguamarga; 4: Rambla of Alcantarilla and Rambla of Sangonera; 5: Saline streams in Mendavia). Shaded surface represents the existing Natura 2000 network in the Iberian Peninsula and Balearic Islands.

Islands, in which the increasing demand on water has lead in many cases to the regulation of the headwaters and the disappearance of the upper reach of permanent streams. We also found that a significant number of high-priority species were located in saline stream systems. These species point to the importance of such lotic saline systems for speciation (Gómez et al., 2000,2002; Abellán et al., 2007), and are vulnerable due to their rarity, and the high degree of anthropogenic pressure on their habitats, usually found in more heavily impacted lowland regions (Williams, 2002; Gómez et al., 2005).

Of the 120 species studied, 73 (61.47%) were identified as having high- conservation priority, these comprising 14.3% of all water beetles recorded from the Iberian Peninsula. We propose that these 73 species should be included a number of 'red lists', including the National Catalogue of Threatened Species in Spain and/or Portugal, on Appendix II of the Habitat Directive (Directive 92/43/CEE), and, potentially on the IUCN Red List. This may seem a high number to include in a list of threatened species, and whilst the inclusion of long lists of inconspicuous species in red lists is questionable (Ribera, 2000), most of us feel that it can be justified on the basis of their use in effective habitat protection. Habitats are usually declared as endangered and protected on the basis of an inventory of species, particularly red list species. In this sense, we emphasize that invertebrates red lists, such as that proposed for water beetles on the basis of our analyses, are valuable in the identification and management of protected area networks. This is especially important in freshwater ecosystems, because, until now, species considered for SAC designation are mostly terrestrial vertebrates and very few aquatic invertebrates have been listed in Annex II of the Habitats Directive (Abellán et al., 2006), hampering effective conservation evaluation of such habitats. As discussed in Section 1, the Iberian and Balearic water beetle fauna is well known, and these insects are known to function as effective surrogates of wider inland water biodiversity, making aquatic Coleoptera an ideal group to use in this form.

In the analyses presented here, we focussed on Ibero–Balearic endemics, and the degree to which these taxa are protected by existing Natura 2000 networks. As a consequence, we failed to consider some species which are rare at a national, or indeed international level. These include some relatively widespread Palaearctic species, rare in Iberia (e.g. *Gyrinus suffriani* and *Hydaticus seminiger*); taxa with a predominantly African distribution whose only European outpost is in southern Iberia (e.g. *C. vulneratus, Methles cribatellus* and *Trichonectes otini*), and a number of rare or endangered Palaeartic species which are not Ibero–Balearic endemics (*A. duvergeri*, *P. acuminatus* and *S. consobrina*). *A. duvergeri* is probably the rarest and least known of the larger species of western European aquatic Coleoptera, occurring in well preserved lowland or mountain ponds, always in low numbers. Formerly known from south-western France, where it is now apparently extinct, it is now recorded only from western Iberia and Sardinia, with old records from west Morocco (Bergsten and Miller, 2006). *P. acuminatus*, although present in Europe and North Africa, is rare throughout its discontinuous geographical range (Horion, 1995), being considered to be on the verge of extinction in central Europe (Kodada, 1991). It requires large, clean, well-oxygenated rivers, with a supply of submerged decaying timber, a threatened and scarce habitat. Finally, *S. consobrina*, another species of clean, large lowland rivers, is considered to be extinct in central Europe (Ribera, 2000), and is increasingly rare in the south (Olmi, 1976; Rico, 1997).

4.2. *Habitats and hotspots*

Most of the hotspots identified in the study area represent isolated headwater streams in mountain areas and saline systems mainly from the south-east of the Iberian Peninsula. These saline systems typically support a particular set of stenotopic, high-priority species (*N. baeticus*, *Ochthebius andalusicus*, *O. delgadoi*, *O. glaber*, *O. montesi*, and *O. tudmirensis*), which occupy these habitats in a number of areas of the peninsula. Nevertheless, it is important to point out that, in spite of the apparent geographical homogeneity of these hotspots, independent evolutionary lineages of these saline water taxa may occur in different regions, and these must feature in conservation planning to enable the preservation of the process generating and maintaining the diversity of the species (Gómez et al., 2000; Abellán et al., 2007). On other hand, we also emphasize the importance of the remaining hotspots, largely located in headwater streams or lagoons in mountain areas throughout the study area. These areas have a rich and often highly endemic fauna, in some cases including species whose distributional ranges are limited to individual mountainous systems. Several of these areas are coincident with those highlighted previously for narrow endemic plants (Domínguez-Lozano et al., 2000), mainly Sierra Nevada, Sierra de Alcaráz and Serra da Estrela), suggesting that they could be important centres of endemism in the Iberian Peninsula and Balearic Islands for different groups of organisms. Other crucial target sites and habitats for protection are freshwater streams and lagoons located principally in Serra de Arga, streams of NW of Mallorca, Los Alcornocales natural park, Sierra de Guadarrama, Sierra Morena, Pre-Pyrenees, Sierra de Ancares and Picos de Euopa in the Cantabrian Mountains.

Hotspots from saline aquatic ecosystems are particularly threatened at present since the lowland and coastal areas where they are located suffer the most intense and frequent changes in land-use (Martínez-Fernández et al., 2000), via dredging and stream canalization, drainage, urbanization and other human developments, pollution and loss of salinity (Gómez et al., 2005; Velasco et al., 2006). Whilst hotspots in mountainous areas may require minimal management for conservation, most contemporary extinctions have affected narrow-range taxa or taxa with strict ecological requirements (Fontaine et al., 2007), such as those of montane areas. Furthermore, these species could be most at risk from ongoing climate change (Thomas et al., 2004; Wilson et al., 2005; Calosi et al., 2007), and by the increasingly amount of water pollution generated through the rapid expansion of rural mountain tourism, and relaxation of rural planning restrictions whose effects are already being felt in the region.

4.3. *Gap analysis and protection from Natura 2000 network*

Hotspot gap analysis revealed the importance of peripheral areas of the Natura 2000 network in protecting high-priority species of water beetles, because an important increase in the number of squares protected depending of the threshold considered has been detected. Therefore, rules used to assign reserves to squares will obviously affect estimates of gaps in the representation of species within conservation areas (Araujo, 2004).

Hotspots are actually less protected by the Natura 2000 network than squares containing few species of high-priority endemic taxa. This may partly be due to the higher number of hotspots associated with lowland saline systems, as discussed above. At present Natura 2000 fails to protect inland saline water bodies in Iberia, despite their high conservation interest, and their narrow distribution in a global context (Williams, 1999; Moreno et al., 1997; Gómez et al., 2000, 2005; Abellán et al., 2007). This failure is probably related to the fact that inland saline habitats are in general socially under-valuated environments, poor in vertebrate species, and because the lowland and coastal areas in which they occur are subject to more intense and frequent changes in land-use (Martínez-Fernández et al., 2000; Sánchez-Fernández et al., 2004b).

From species gap analysis, we suggest that special attention should also be focused on four species whose distribution is not currently included in Natura 2000 networks or if included is only present as a minor proportion. It is recommended that the boundaries of the SCI or SPAs closest to the distribution of these species are extended to better include these high-priority species as follows: Sierra Subetica for *I. cermenius,* Sierra de Picón for *H. quetiae*, Sierra Nevada for *L. monfortei* and Saladares de Cordovilla, Agramón y Laguna de Alboraj, Complejo lagunar de la Charca de Chiprana and Laguna de Pitillas for *O. irenae*.

Finally, despite the high degree of overlap detected when the distribution maps of species were superimposed on the Natura 2000 network, and the fact that Natura 2000 should, theoretically, provide an appropriate mechanism to avoid deterioration of natural habitats, it is important to point out that the occurrence of a species within a protected area (even with multiple capture records) is not a guarantee of long-term survival. At present the management of SACs and SPAs is focused to protect the habitat and/or species for which the site is designated (usually *only* plants and vertebrates) not the entire biodiversity of a site. Thus, we have a "virtual protection" of the remaining biodiversity in such areas, and no guarantee of success (Sánchez-Fernández et al., 2004b). In particular, at present SACs and SPAs often fail to address issues critical for aquatic biodiversity, such as catchment integrity, extra-SAC or SPA catchment land-use, hydrology, and the introduction of non-native species (Lake, 1980; Skelton et al., 1995; Moyle and Randall, 1998). This drawback could be overcome by the identification and declaration of microreserves or areas of special protection for aquatic biodiversity within these extensive areas, and applying specific management measures to protect this aquatic biota. Many activities, such as dam building, water diversion for agriculture, land-use disturbance in the catchments, or the introduction of alien species (Saunders et al., 2002), may occur well outside park boundaries yet still have major negative consequences for freshwater habitats within. Thus, whole-catchment management and natural-flow maintenance are indispensable strategies for freshwater biodiversity conservation (Abellán et al., 2006). Therefore, identifying threatened species and areas along with the above guidelines must be taken into consideration to adequately protect freshwater biodiversity in the future.

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Appendix

No.	Family	Species	Code
1	DYTISCIDAE	*Hygrotus fresnedai* (Fery, 1992)	Hyt.fres
2	DYTISCIDAE	*Hydroporus brancoi brancoi* Rocchi, 1981	Hyd.bran
3	DYTISCIDAE	*Hydroporus brancoi gredensis* Fery, 1999	Hyd.gred
4	DYTISCIDAE	*Hydroporus brancuccii* Fery, 1987	Hyd.brac
5	DYTISCIDAE	*Hydroporus cantabricus* Sharp, 1882	Hyd.cant
6	DYTISCIDAE	*Hydroporus constantini* Hernando and Fresneda, 1996	Hyd.cons
7	DYTISCIDAE	*Hydroporus decipiens** Sharp, 1878	Hyd.deci
8	DYTISCIDAE	*Hydroporus lluci* Fery, 1999	Hyd.lluc
9	DYTISCIDAE	*Hydroporus necopinatus necopinatus* Fery, 1999	Hyd.neco
10	DYTISCIDAE	*Hydroporus nevadensis* Sharp, 1882	Hyd.neva
11	DYTISCIDAE	*Hydroporus normandi alhambrae* Fery, 1999	Hyd.alha
12	DYTISCIDAE	*Hydroporus normandi normandi* Régimbart, 1903	Hyd.norm
13	DYTISCIDAE	*Hydroporus paganettianus* Scholz, 1923	Hyd.paga
14	DYTISCIDAE	*Hydroporus sabaudus sierranevadensis* Shaverdo, 2004	Hyd.sier
15	DYTISCIDAE	*Hydroporus vagepictus* Fairmaire and Laboulbène, 1854	Hyd.vage
16	DYTISCIDAE	*Hydroporus vespertinus* Fery and Heindrich, 1988	Hyd.vesp
17	DYTISCIDAE	*Graptodytes castilianus* Fery, 1995	Grt.cast
18	DYTISCIDAE	*Iberoporus cermenius* Castro and Delgado, 2000	Ibe.cerm
19	DYTISCIDAE	*Rhithrodytes agnus agnus* Foster, 1993	Rhi.agnu
20	DYTISCIDAE	*Rhithrodytes agnus argaensis* Bilton and Fery, 1996	Rhi.arga
21	DYTISCIDAE	*Rhithrodytes bimaculatus* (Dufour, 1852)	Rhi.bima
22	DYTISCIDAE	*Stictonectes occidentalis* Fresneda and Fery, 1990	Stn.occi
23	DYTISCIDAE	*Deronectes algibensis* Fery and Fresneda, 1988	Der.algi

(*continued on next page*)

Appendix – *continued*

No.	Family	Species	Code
24	DYTISCIDAE	*Deronectes angusi* Fery and Brancucci, 1990	Der.angu
25	DYTISCIDAE	*Deronectes aubei sanfilippoi* Fery and Brancucci, 1997	Der.aube
26	DYTISCIDAE	*Deronectes bicostatus* (Schaum, 1864)	Der.bico
27	DYTISCIDAE	*Deronectes brannanii* (Schaufuss, 1869)	Der.bran
28	DYTISCIDAE	*Deronectes costipennis costipennis* Brancucci, 1983	Der.cost
29	DYTISCIDAE	*Deronectes costipennis gignouxi* Fery and Brancucci, 1989	Der.cosg
30	DYTISCIDAE	*Deronectes delarouzei* (du Val, 1857)	Der.dela
31	DYTISCIDAE	*Deronectes depressicollis* (Rosenhauer, 1856)	Der.depr
32	DYTISCIDAE	*Deronectes ferrugineus* Fery and Brancucci, 1987	Der.ferr
33	DYTISCIDAE	*Deronectes fosteri* Aguilera and Ribera, 1996	Der.fost
34	DYTISCIDAE	*Deronectes wewalkai* Fery and Fresneda, 1988	Der.wewa
35	DYTISCIDAE	*Stictotarsus bertrandi* Legros, 1956	Stt.bert
36	DYTISCIDAE	*Stictotarsus ibericus** Dutton and Angus, 2007	Stt.iber
37	DYTISCIDAE	*Nebrioporus bucheti cazorlensis* (Lagar, Fresneda and Hernando, 1987)	Neb.buch
38	DYTISCIDAE	*Nebrioporus carinatus* (Aubé, 1836)	Neb.cari
39	DYTISCIDAE	*Nebrioporus croceus* Angus, Fresneda and Fery, 1992	Neb.croc
40	DYTISCIDAE	*Nebrioporus fabressei* (Régimbart, 1901)	Neb.fabr
41	DYTISCIDAE	*Nebrioporus baeticus* (Schaum, 1864)	Neb.baet
42	DYTISCIDAE	*Agabus nevadensis* Lindberg, 1939	Aga.neva
43	DYTISCIDAE	*Agabus picotae* Foster and Bilton, 1997	Aga.pico
44	DYTISCIDAE	*Ilybius dettneri* Fery, 1986	Ily.dett
45	HELOPHORIDAE	*Helophorus hispanicus* (Sharp, 1915)	Hep.hisp
46	HELOPHORIDAE	*Helophorus bameuli* Angus, 1987	Hep.bame
47	HELOPHORIDAE	*Helophorus korotyaevi* Angus, 1985	Hep.koro
48	HELOPHORIDAE	*Helophorus leontis* Angus, 1985	Hep.leon
49	HELOPHORIDAE	*Helophorus nevadensis* Sharp, 1916	Hep.neva
50	HELOPHORIDAE	*Helophorus jocoteroi* Angus and Díaz Pazos, 1991	Hep.joco
51	HELOPHORIDAE	*Helophorus seidlitzii* Kuwert, 1885	Hep.seid
52	HYDROCHIDAE	*Hydrochus angusi* Valladares, 1988	Hch.angi
53	HYDROCHIDAE	*Hydrochus ibericus* Valladares, Díaz Pazos and Delgado, 1999	Hch.iber
54	HYDROCHIDAE	*Hydrochus interruptus* Heyden, 1870	Hch.inte
55	HYDROCHIDAE	*Hydrochus nooreinus* Henegouven and Sáinz-Cantero, 1992	Hch.noor
56	HYDROPHILIDAE	*Laccobius gloriana* Gentili and Ribera, 1998	Lab.glor
57	HYDRAENIDAE	*Hydraena altamirensis* Díaz Pazos and Garrido, 1993	Hdn.alta
58	HYDRAENIDAE	*Hydraena catalonica* Fresneda, Aguilera and Hernando, 1994	Hdn.cata
59	HYDRAENIDAE	*Hydraena gaditana* Lagar and Fresneda, 1990	Hdn.gadi
60	HYDRAENIDAE	*Hydraena hispanica* Ganglbauer, 1901	Hdn.hisp
61	HYDRAENIDAE	*Hydraena iberica* Orchymont, 1936	Hdn.iber
62	HYDRAENIDAE	*Hydraena lusitana* Berthélemy, 1977	Hdn.lusi
63	HYDRAENIDAE	*Hydraena madronensis* Castro, García and Ferreras, 2000	Hdn.madr
64	HYDRAENIDAE	*Hydraena manfredjaechi* Delgado and Soler, 1991	Hdn.manf
65	HYDRAENIDAE	*Hydraena monstruosipes* Ferro, 1986	Hdn.mons
66	HYDRAENIDAE	*Hydraena tatii* Sainz-Cantero and Alba-Tercedor, 1989	Hdn.tati
67	HYDRAENIDAE	*Hydraena zezerensis* Díaz Pazos and Bilton, 1994	Hdn.zeze
68	HYDRAENIDAE	*Hydraena afussa* Orchymont, 1936	Hdn.afus
69	HYDRAENIDAE	*Hydraena albai* Sáinz-Cantero, 1993	Hdn.alba
70	HYDRAENIDAE	*Hydraena alcantarana* Ieniesta, 1985	Hdn.alca
71	HYDRAENIDAE	*Hydraena balaerica* d́Orchymont, 1930	Hdn.bale
72	HYDRAENIDAE	*Hydraena bolivari* Orchymont, 1936	Hdn.boli
73	HYDRAENIDAE	*Hydraena corinna* Orchymont, 1936	Hdn.cori
74	HYDRAENIDAE	*Hydraena delia* Balfour-Browne, 1978	Hdn.deli
75	HYDRAENIDAE	*Hydraena gavarrensis* Jäch, Diaz and Martinoy, 2005	Hdn.gava
76	HYDRAENIDAE	*Hydraena isabelae* Castro and Herrera, 2001	Hdn.isab
77	HYDRAENIDAE	*Hydraena lucasi* Lagar, 1984	Hdn.luca
78	HYDRAENIDAE	*Hydraena marcosae* Aguilera, Hernando and Ribera, 1997	Hdn.marc
79	HYDRAENIDAE	*Hydraena marinae* Castro, 2004	Hdn.mari
80	HYDRAENIDAE	*Hydraena mecai* Millán and Aguilera, 2000	Hdn.meca
81	HYDRAENIDAE	*Hydraena quetiae* Castro, 2000	Hdn.quet
82	HYDRAENIDAE	*Hydraena servilia* Orchymont, 1936	Hdn.serv
83	HYDRAENIDAE	*Hydraena sharpi* Rey, 1886	Hdn.shar
84	HYDRAENIDAE	*Hydraena unca* Valladares, 1989	Hdn.unca
85	HYDRAENIDAE	*Limnebius cordobanus* Orchymont, 1938	Lib.cord
86	HYDRAENIDAE	*Limnebius gerhardti* Heyden, 1870	Lib.gerh
87	HYDRAENIDAE	*Limnebius hilaris* Balfour-Browne, 1976	Lib.hila

Appendix – *continued*

No.	Family	Species	Code
88	HYDRAENIDAE	*Limnebius hispanicus* Orchymont, 1941	Lib.hisp
89	HYDRAENIDAE	*Limnebius ibericus* Balfour-Browne, 1978	Lib.iber
90	HYDRAENIDAE	*Limnebius ignarus* Balfour-Browne, 1978	Lib.igna
91	HYDRAENIDAE	*Limnebius lusitanus* Balfour-Browne, 1978	Lib.lusi
92	HYDRAENIDAE	*Limnebius millani* Ribera and Hernando, 1998	Lib.mill
93	HYDRAENIDAE	*Limnebius minoricensis* Jäch, Valladares and García-Avilés, 1996	Lib.mino
94	HYDRAENIDAE	*Limnebius monfortei* Fresneda and Ribera, 1998	Lib.monf
95	HYDRAENIDAE	*Limnebius montanus* Balfour-Browne, 1978	Lib.mont
96	HYDRAENIDAE	*Limnebius nanus* Jäch, 1993	Lib.nanu
97	HYDRAENIDAE	*Limnebius ordunyai* Fresneda and Ribera, 1998	Lib.ordu
98	HYDRAENIDAE	*Ochthebius bellieri* Kuwert, 1887	Och.bell
99	HYDRAENIDAE	*Ochthebius cantabricus** Balfour-Browne, 1978	Och.cant
100	HYDRAENIDAE	*Ochthebius ferroi* Fresneda, Lagar and Hernando, 1993	Och.ferr
101	HYDRAENIDAE	*Ochthebius heydeni** Kuwert, 1887	Och.heyd
102	HYDRAENIDAE	*Ochthebius irenae* Ribera and Millán, 1998	Och.iren
103	HYDRAENIDAE	*Ochthebius albacetinus* Ferro, 1984	Och.alba
104	HYDRAENIDAE	*Ochthebius andalusicus* Jäch and Castro, 1999	Och.anda
105	HYDRAENIDAE	*Ochthebius caesaraugustae* Jäch, Ribera and Aguilera, 1998	Och.caes
106	HYDRAENIDAE	*Ochthebius delgadoi* Jäch, 1994	Och.delg
107	HYDRAENIDAE	*Ochthebius diazi* Jäch, 1999	Och.diaz
108	HYDRAENIDAE	*Ochthebius gayosoi* Jäch, 2001	Och.gayo
109	HYDRAENIDAE	*Ochthebius glaber* Montes and Soler, 1988	Och.glab
110	HYDRAENIDAE	*Ochthebius javieri* Jäch, 2000	Och.javi
111	HYDRAENIDAE	*Ochthebius montesi* Ferro, 1984	Och.mont
112	HYDRAENIDAE	*Ochthebius pedroi* Jäch, 2000	Och.pedr
113	HYDRAENIDAE	*Ochthebius semotus* Jäch, 2001	Och.semo
114	HYDRAENIDAE	*Ochthebius tudmirensis* Jäch, 1997	Och.tudm
115	ELMIDAE	*Oulimnius bertrandi* Berthélemy, 1964	Oul.bert
116	ELMIDAE	*Oulimnius cyneticus* Berthélemy and Terra, 1979	Oul.cyne
117	ELMIDAE	*Oulimnius echinatus* Berthélemy, 1979	Oul.echi
118	ELMIDAE	*Oulimnius tuberculatus perezi* Sharp, 1872	Oul.tubp
119	ELMIDAE	*Limnius perrisi carinatus* Perez-Arcas, 1865	Lin.perc
120	DRYOPIDAE	*Dryops championi* Dodero, 1918	Dry.cham

*Species with uncertain endemicity status.

REFERENCES

Abellán, P., Gómez-Zurita, J., Millán, A., Sánchez-Fernández, D., Velasco, J., Galián, J., Ribera, I., 2007. Conservation genetics in hypersaline inland waters: mitochondrial diversity and phylogeography of an endangered Iberian beetle (Coleoptera: Hydraenidae). Conservation Genetics 8, 79–88.

Abellán, P., Sánchez-Fernández, D., Velasco, J., Millán, A., 2005. Assessing conservation priorities for insects: status of water beetles in southeast Spain. Biological Conservation 121, 79–90.

Abellán, P., Sánchez-Fernández, D., Velasco, J., Millán, A., 2006. Effectiveness of protected area networks in representing freshwater biodiversity: the case of a Mediterranean river basin (south-eastern Spain). Aquatic Conservation: Marine and Freshwater Ecosystems 16, 1–14.

Allan, J.D., Flecker, A.S., 1993. Biodiversity conservation in running waters. Bioscience 43, 32–43.

Araujo, M.B., 2004. Matching species with reserves – uncertainties from using data at different resolutions. Biological Conservation 118, 533–538.

Bergsten, J., Miller, K.B., 2006. Taxonomic revision of the Holarctic diving beetle genus *Acilius* Leach (Coleoptera: Dytiscidae). Systematic Entomology 31, 145–197.

Bilton, D.T., McAbendroth, L., Bedford, A., Ramsay, P.M., 2006. How wide to cast the net? Cross-taxon congruence of species richness, community similarity and indicator taxa in ponds. Freshwater Biology 51, 578–590.

Calosi, P., Bilton, D.T., Spicer, J.I., 2007. Thermal tolerance, acclimatory capacity and vulnerability to global climate change. Biology Letters 4, 99–102.

Darwall, W.R.T., Vié, J.C., 2005. Identifying important sites for conservation of freshwater biodiversity: extending the species-based approach. Fisheries Management and Ecology 12, 287–293.

Domínguez-Lozano, F., Galicia-Herbada, D., Moreno Rivero, L., Moreno Saiz, J.M., Sainz Ollero, H., 1996. Threatened plants in Peninsular and Balearic Spain: a report based on the EU Habitats Directive. Biological Conservation 76, 123–133.

Domínguez-Lozano, F., Galicia-Herbada, D., Moreno Rivero, L., Moreno Saiz, J.M., Sainz Ollero, H., 2000. Areas of high floristic endemism in Iberia and the Balearic islands: an approach to biodiversity conservation using narrow endemics. Belgian Journal of Entomology 2, 171–185.

Fitzpatrick, U., Murray, T.E., Paxton, R.J., Brown, M.J., 2007. Building on IUCN regional red lists to produce lists of species of conservation priority: a model with Irish Bees. Conservation Biology 21 (5), 1324–1332.

Fontaine, B., Bouchet, Ph., Van Achterberg, K., Alonso-Zarazaga, M.A., Araujo, R., Asche, M., Aspöck, U., Audisio, P., Aukema, P.,

Bailly, et al, 2007. The European union's 2010 target: putting rare species in focus. Biological Conservation 139, 167–185.
Gaston, K.J., 1994. Rarity. Chapman and Hall, London.
Gómez, A., Carvalho, G.R., Lunt, D.H., 2000. Phylogeography and regional endemism of a passively dispersing zooplankter: mitochondrial DNA variation in rotifer resting egg banks. Proceedings of the Royal Society of London Series B 267, 2189–2197.
Gómez, A., Serra, M., Carvalho, G.R., Lunt, D.H., 2002. Speciation in ancient cryptic species complexes: Evidence from the molecular phylogeny of *Brachionus plicatilis* (Rotifera). Evolution 56, 1431–1444.
Gómez, R., Hurtado, I., Suárez, M.L., Vidal-Abarca, M.R., 2005. Ramblas in south-east Spain: threatened and valuable ecosystems. Aquatic Conservation: Marine and Freshwater Ecosystems 15, 387–402.
Hollis, G.E., 1995. Wetlands and river restoration in Europe and the Mediterranean. In: Montes, C., Oliver, G., Molina, F., Cobos, J. (Eds.), Bases Ecológicas para la Restauración de Humedales en la Cuenca Mediterránea. Junta de Andalucía, Sevilla, pp. 125–142.
Horion, A., 1995. Faunistik der Mitteleuropaischen Käfer. Entomologische Arbeiten aus dem Museum Georg Frey 4, 1–280.
Hutchings, P.A., Ponder, W.F., 1999. Workshop: criteria for assessing and conserving threatened invertebrates. In: Ponder, W., Lunney, D., (Eds.), The Other 99%. The Conservation and Biodiversity of Invertebrates. Transactions of the Royal Zoological Society of New South Wales, Mosman, pp. 297–315.
IUCN, 2004. Red List of Threatened Species. A Global Species Assessment IUCN-SSC, Cambridge. <http://www.iucn.org/themes/ssc/red_list_2004/GSA_book/Red_List_2004_book.pdf>.
Kati, V., Dufrêne, M., Legakis, A., Grill, A., Lebrun, P., 2003. Conservation management for Orthoptera in the Dadia reserve, Greece. Biological Conservation 115, 33–44.
Keith, P., 2000. The part played by protected areas in the conservation of threatened French freshwater fish. Biological Conservation 92, 265–273.
Kerr, J.T., Sugar, A., Packer, L., 2000. Indicator taxa, rapid biodiversity assessment, and nestedeness in an endangered ecosystems. Conservation Biology 14 (6), 1726–1734.
Kodada, J., 1991. *Potamophilus acuminatus* (F.) not extinct in Central Europe! (Coleoptera: Elmidae). Koleopterologische Rundschau 61, 157–158.
Lake, P.S., 1980. Conservation. In: Williams, W.D. (Ed.), An Ecological Basis for Water Resource Management. ANU Press, Canberra, pp. 163–173.
Linnell, J.D.C., Swenson, J.E., Andersen, R., 2000. Conservation of biodiversity in Scandinavian boreal forests: large carnivores as flagships, umbrellas, indicators, or keystones? Biodiversity and Conservation 9, 857–868.
López-Martínez, N., 1989. Tendencias en Paleobiogeografía. El futuro de la biogeografía del pasado. In: Aguirre, E. (Ed.), Paleontología, nuevas tendencias. C.S.I.C, Madrid, pp. 271–296.
Mace, G.M., Lande, R., 1991. Assessing extinction threats: toward a reevaluation of IUCN threatened species categories. Conservation Biology 5 (2), 148–157.
Margules, C.R., Pressey, R.L., 2000. Systematic conservation planning. Nature 405, 243–253.
Martínez, I., Carreño, F., Escudero, A., Rubio, A., 2006. Are threatened lichen species well-protected in Spain? Effectiveness of a protected areas network. Biological Conservation 133, 500–511.
Martínez-Fernández, J., Esteve-Selma, M.A., Calvo-Sendín, J.F., 2000. Environmental and socio-economic interaction in the evolution of traditional irrigate lands. A dynamic system model. Human Ecology 28, 279–299.
Master, L.L., Flack, S.R., Stein, B.A., 1998. Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity. The Nature Conservancy, Arlington, VA.
May, R.M., Lawton, J.H., Stork, N.E., 1995. Assessing extinction rates. In: Lawton, J.H., May, R.M. (Eds.), Extinction Rates. Oxford University Press, Oxford, pp. 1–24.
Médail, F., Quézel, P., 1997. Hot-spots analysis for conservation of plant biodiversity in the Mediterranean basin. Annals of the Missouri Botanical Garden 84, 112–127.
Millán, A., Moreno, J.L., Velasco, J., 2002. Estudio faunístico y ecológico de los coleópteros y heterópteros acuáticos y semiacuáticos de la provincia de Albacete. Instituto de Estudios Albacetenses, Albacete.
Mittermeier, R.A., Myers, N., Thomsen, J.B., da Fonseca, G.A.B., Olivieri, S., 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. Conservation Biology 12, 516–520.
Moreno, J.L., Millán, A., Suárez, M.L., Vidal-Abarca, M.R., Velasco, J., 1997. Aquatic Coleoptera and Heteroptera assemblages in waterbodies from ephemeral coastal streams ("ramblas") of south-eastern Spain. Archiv für Hydrobiologie 141, 93–107.
Moyle, P.B., Randall, P.J., 1998. Evaluating the biotic integrity of watersheds in the Sierra Nevada, California. Conservation Biology 12, 1318–1326.
Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J., 2000. Biodiversity hotspots for conservation priorities. Nature 403, 853–858.
Naveh, Z., Lieberman, A., 1984. Landscape Ecology: Theory and Applications. Springer-Verlag, New York.
New, T.S., Sands, D.P.A., 2003. The listing and de-listing of invertebrate species for conservation in Australia. Journal of Insect Conservation 7 (4), 199–205.
Olmi, M., 1976. Fauna d'Italia, vol. XII: Coleoptera Dryopidae Elminthidae. Edizioni Calderini, Bologna.
Ramos, M.A., Lobo, J.M., Esteban, M., 2001. Ten years inventorying the Iberian fauna: results and perspectives. Biodiversity and Conservation 10, 19–28.
Rabinowitz, D., Cairns, S., Dillon, T., 1986. Seven forms of rarity and their frequency in the flora of the British Isles. In: Soule, M. (Ed.), Conservation Biology, The Science of Scarcity and Diversity. Sinauer, Mass, pp. 182–204.
Reyjol, Y., Hugueny, B., Pont, D., Bianco, P.G., Beier, U., Caiola, N., Casals, F., Cowx, I., Economou, A., Ferreira, T., Haidvogl, G., Noble, R., de Sostoa, A., Vigneron, T., Virbickas, T., 2007. Patterns in species richness and endemism of European freshwater fish. Global Ecology and Biogeography 16, 65–75.
Ribera, I., 2000. Biogeography and conservation of Iberian water beetles. Biological Conservation 92, 131–150.
Ribera, I., Hernando, C., Aguilera, P., 1998. An annotated checklist of the Iberian water beetles (Coleoptera). Zapateri 8, 43–111.
Ribera, I., Foster, G.N., Vogler, A.P., 2003. Does habitat use explain large scale diversity patterns in European water beetles? Ecography 26, 145–152.
Ribera, I., Vogler, A.P., 2004. Speciation of Iberian diving beetles in Pleistocene refugia (Coleoptera, Dytiscidae). Molecular Ecology 13, 179–193.
Ricciardi, A., Rasmussen, J.B., 1999. Extinction rates in North American freshwater fauna. Conservation Biology 13, 1220–1222.
Rico, E., 1997. Distribución de los Elmidae (Coleoptera: Dryopoidea) en la Península Ibérica e islas Baleares. Graellsia 52, 115–147.
Sánchez-Fernández, D., Abellán, P., Mellado, A., Velasco, J., Millán, A., 2006. Are water beetles good indicators of biodiversity in Mediterranean aquatic ecosystems? The case of the Segura river basin (SE Spain). Biodiversity and Conservation 15, 4507–4520.

Sánchez-Fernández, D., Abellán, P., Velasco, J., Millán, A., 2004a. Selecting areas to protect the biodiversity of aquatic ecosystems in a semiarid Mediterranean region. Aquatic Conservation: Marine and Freshwater Ecosystems 14, 465–479.

Sánchez-Fernández, D., Abellán, P., Barahona, J., Velasco, J., Millán, A., 2004b. El regadío amenaza a los mejores ecosistemas acuáticos de Murcia. Quercus 215, 68–69.

Saunders, D.L., Meeuwig, J.J., Vincent, A.C.J., 2002. Freshwater protected areas: strategies for conservation. Conservation Biology 16 (1), 30–41.

Skelton, P.H., Cambray, J.A., Lombard, A.T., Benn, G.A., 1995. Patterns of distribution and conservation status of freshwater fishes in South Africa. South African Journal of Zoology 30, 71–81.

Stoate, C., Boatman, N.D., Borralho, R.J., Carvalho, C.R., Snoo, G.R., Eden, P., 2001. Ecological impacts of arable intensification in Europe. Journal of Environmental Management 29, 337–365.

Strayer, D.L., 2006. Challenges for freshwater invertebrate conservation. Journal of the North American Benthological Society 25 (2), 271–287.

Sutherland, W.J., 2000. The Conservation Handbook. Research, Management and Policy. Blackwell Science, Cambridge.

Thomas, C.D., Cameron, A., Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., Hannah, L., Hughes, L., Huntley, B., van Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Peterson, A.T., Phillips, O.L., Williams, S.E., 2004. Extinction risk from climate change. Nature 427, 145–148.

Velasco, J., Millán, A., Hernández, J., Gutiérrez, C., Abellán, P., Sánchez, D., Ruiz, M., 2006. Response of biotic communities to salinity changes in a Mediterranean hypersaline stream. Saline Systems 2 (12), 1–15.

Verdú, J.R., Galante, E., 2006. Libro Rojo de los Invertebrados de España. Dirección General para la Biodiversidad, Ministerio de Medio Ambiente, Madrid.

Wilson, E.O., 1988. The current state of biological diversity. In: Wilson, E.O. (Ed.), Biodiversity. National Academy Press, Washington, DC, pp. 3–18.

Wilson, R.J., Gutiérrez, D., Gutiérrez, J., Martínez, D., Agudo, R., Monserrat, V.J., 2005. Changes to elevational limits and extent of species ranges associated with climate change. Ecology Letters 8, 1138–1146.

Williams, W.D., 1999. Conservation of wetlands in drylands: a key global issue. Aquatic Conservation: Marine and Freshwater Ecosystems 9, 517–522.

Williams, W.D., 2002. Environmental threats to salts lakes and the likely status of inland saline ecosystems 2025. Environmental Conservation 29, 154–167.

Williams, P.H., Humphries, C., Aráujo, M.B., Lampinen, R., Hagemeijer, W., Gasc, J.P., Mitchell-Jones, T., 2000. Endemism and important areas for representing European biodiversity: a preliminary exploration of atlas data for plants and terrestrial vertebrates. Belgian Journal of Entomology 2, 21–46.