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# Why Not Assess Subspecies Status Within Taxa of Conservation Concern?

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**Abstract:** In 2011, the European Union Member States adopted a new system for updating the European Commission under Article 12 of the Birds Directive (2009/147/EC), and every six years, Member States will report on measures taken to conserve birds. The main assessment is carried out on the basis of species censuses and their temporal trends. Regrettably, however, the assessment only takes into account the species at the global level and not the recognized valid subspecies, which represent important *tesserae* of taxonomic diversity. This paper constructively discusses some of the results of the fourth assessment and proposes some modifications to future assessments to achieve more inclusive results of at-risk subspecies.

**Keywords:** endemism; subspecies; endangered populations; assessment; *Alectoris rufa*; *Alectoris graeca*; *Lanius meridionalis*; *Passer italiae*; *Turnix sylvaticus*; *Hydrobates pelagicus*

## 1. Introduction

According to Burfield et al. [1], although Species of Conservation Concern (hereafter 'SPECs') have no formal legal status, their classification has strongly influenced bird conservation in Europe. SPECs categories have been used to identify the most important habitats for birds in Europe and the conservation measures required to maintain or restore their populations in the wider environment. Three categories represent SPECs: species that are either of global conservation concern (Spec1) or of European conservation concern, either concentrated in Europe (Spec2) or not (Spec3). The percentage of SPECs (38–43%) has not changed much across the first three assessments, but the proportion of Spec1 species increased from 24 (5%) in 1994 to 40 (8%) in 2004, 68 (12%) in 2017 and 74 (14%) in 2023. This, of course, is dependent on the growing number of European species of global conservation concern, which also include popular species, such as the kittiwake *Rissa tridactyla*, the puffin *Fratercula arctica* and the turtle dove *Streptopelia turtur* [1].

In 2011, the European Union Member States adopted a new system for updating the European Commission under Article 12 of the Birds Directive (2009/147/EC). Indeed, every six years, Member States must report on measures they have taken to conserve birds, including data on species' population sizes and trends. This results in a requirement for the governments of every EU country to provide data on the quantity and population trends of the various regularly breeding species and some wintering ones. Many of these data have found their way into the atlases that each country has published in recent years. The fourth assessment of species of European conservation concern [1] includes 74 Spec1. This paper aims to address two issues: (i) the importance of isolated populations currently recognized as subspecies in future assessments and (ii) a reconsideration of the concept of endemism.

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## 2. Methods

Table 1 lists the Spec1 species reported by Burfield et al. [1], which have been clustered in biogeographical and habitat groups, with populations concentrated and not concentrated in Europe, respectively. Sixteen of them are considered European breeding endemics. Below I will explain the meaning of endemic taxon and try to emphasize the importance of including biogeographic subspecies in future assessments. They represent evolutionary unique populations within a species [2]; according to Amadon [3], the only quantitative subspecies definition is the 75% rule, which is that a subspecies is valid if 75% or more of a population is separable from all members of the overlapping population (however, see Patten & Unitt [4]). Haig et al. [2] proposed subspecies criteria wherein minimal biological requirements should include two criteria based on the discreteness of the population in relation to the remainder of the species to which it belongs and the biological significance of the population to the species.

Macaronesian seabirds, the Balearic shearwater *Puffinus mauretanicus*, the Spanish imperial eagle *Aquila adalberti*, the Corsican nuthatch *Sitta whiteheadi*, the aquatic warbler *Acrocephalus paludicola* and Macaronesian landbirds may be considered endemic taxa following the Long et al. [5] criteria; apart from some Macaronesian landbirds not treated by Burfield et al. [1], other birds deserve some comments.

**Table 1.** Seventy-four Spec1 listed by Burfield et al. [1] with populations concentrated and not concentrated in Europe, divided into biogeographical and habitat groups. Group species (* = European breeding endemics; CR = critically endangered; D = declining; E = extinct; EN = endangered; NE = not evaluated; NT = near threatened; R = rare; RE = regionally extinct; SF = former spec, which have formerly qualified as SPECs in one or more earlier assessments; VU = vulnerable). Note: Burfield et al. [1] reported the slender-billed curlew *Numenius tenuirostris* as CR, but more recently Buchanan et al. [6] declared it as extinct.

| **With Populations Concentrated in Europe (n = 34)** |
|---|
| Macaronesian seabirds: Zino's petrel* *Pterodroma madeira* (EN), Desertas petrel* *Pterodroma deserta* (VU), Monteiro's storm-petrel* *Hydrobates monteiroi* (VU). |
| Mediterranean seabirds: Balearic shearwater* *Puffinus mauretanicus* (CR), Yelkouan shearwater *Puffinus yelkouan* (VU), Audouin's gull *Larus audouinii* (VU). |
| Atlantic/Baltic seabirds: Atlantic puffin *Fratercula arctica* (VU), velvet scoter *Melanitta fusca* (VU), common eider *Somateria mollissima* (NT). |
| Wet grassland waders: Eurasian oystercatcher *Haematopus ostralegus* (NT), northern lapwing *Vanellus vanellus* (NT), Eurasian curlew *Numenius arquata* (NT), black-tailed godwit *Limosa limosa* (NT). |
| Steppe grassland birds: great bustard *Otis tarda* (VU), little bustard *Tetrax tetrax* (NT), red-legged partridge* *Alectoris rufa* (NT). |
| Montane galliforms: Caucasian grouse *Lyrurus mlokosiewiczi* (NT), rock partridge* *Alectoris graeca* (NT). |
| Mediterranean passerines: Iberian grey shrike* *Lanius meridionalis* (VU), Corsican nuthatch* *Sitta whiteheadi* (VU), Italian sparrow* *Passer italiae* (VU), woodchat shrike *Lanius senator* (NT), Dartford warbler *Curruca undata* (NT), cinereous bunting *Emberiza cineracea* (NT). |
| Macaronesian landbirds: Gran Canaria blue chaffinch* *Fringilla polatzeki* (EN), Azores bullfinch* *Pyrrhula murina* (VU), white-tailed laurel pigeon* *Columba junoniae* (NT), Fuerteventura stonechat* *Saxicola dacotiae* (NT), Tenerife blue chaffinch* *Fringilla teydea* (NT). |
| Others: red-breasted goose *Branta ruficollis* (VU), Spanish imperial eagle* *Aquila adalberti* (VU), aquatic warbler* *Acrocephalus paludicola* (VU), Dalmatian pelican *Pelecanus crispus* (NT), redwing *Turdus iliacus* (NT). |

**Table 1.** *Cont.*

| With Populations not Concentrated in Europe (n = 40) |
| --- |
| White-headed duck *Oxyura leucocephala* (VU), lesser white-fronted goose *Anser erythropus* (VU), long-tailed duck *Clangula hyemalis* (D), Steller's eider *Polysticta stelleri* (R), marbled teal *Marmaronetta angustirostris* (VU), common pochard *Aythya ferina* (VU), ferruginous duck *Aythya nyroca* (SF), horned grebe *Podiceps auritus* (NT), European turtle dove *Streptopelia turtur* (VU), red-necked nightjar *Caprimulgus ruficollis* (NT), Siberian crane *Leucogeranus leucogeranus* (NE), African houbara *Clamydotis undulata* (VU), Asian houbara *Clamydotis macquenii* (NE), yellow-billed loon *Gavia adamsi* (VU), Leach's storm petrel *Hydrobates leucorhous* (NT), sooty shearwater *Ardenna grisea* (NE), northern bald ibis *Geronticus eremita* (RE), sociable lapwing *Vanellus gregarius* (CR), slender-billed curlew *Numenius tenuirostris* (E), bar-tailed godwit *Limosa lapponica* (SF), red knot *Calidris canutus* (SF), curlew sandpiper *Calidris ferruginea* (SF), great snipe *Gallinago media* (D), black-winged pratincole *Glareola nordmanni* (R), ivory gull *Pagophila eburnea* (VU), black-legged kittiwake *Rissa tridactyla* (VU), snowy owl *Bubo scandiacus* (R), bearded vulture *Gypaetus barbatus* (NT), Egyptian vulture *Neophron percnopterus* (VU), Rüppell's vulture *Gyps rueppelli* (NE), cinereous vulture *Aegypius monachus* (R), greater spotted eagle *Clanga clanga* (VU), steppe eagle *Aquila nipalensis* (CR), eastern imperial eagle *Aquila heliaca* (R), pallid harrier *Circus macrourus* (R), red-footed falcon *Falco vespertinus* (VU), saker falcon *Falco cherrug* (EN), Dupont's lark *Chersophilus duponti* (VU), yellow-breasted bunting *Emberiza aureola* (CR), rustic bunting *Emberiza rustica* (D). |

## 3. Results

### *3.1. Concept of Endemism*

Following Hoban et al. [7], genetic diversity is recognized as one of three basic elements of biodiversity, that is, diversity within species, between species and of ecosystems. According to Minelli [8] and Anderson [9], endemism describes a taxon whose distribution is limited to a geographically confined territory, often small and localized. Thus, a taxon is endemic to a biogeographic region if it only occurs in that area, which, however, may differ in size. Many endemic taxa are represented by allopatric subpopulations, characterized by the following: (i) a unique geographic range or habitat, (ii) a group of phylogenetically concordant arrays of phenotypic and genetic characters and (iii) a unique natural history but low genetic divergence [10,11]. Generally, island populations have reduced gene flow with continental populations, and we consequently could expect that they diverge genetically at a faster rate than continental ones. Overall, we may consider those taxa as endemic, the distribution of which is limited to a geographically distinct and localized territory < 50,000 km$^2$, as proposed by Long et al. [5] for the identification of Endemic Bird Areas.

### *3.2. Case Studies of Taxonomic and Conservation Challenges*

#### 3.2.1. Red-Legged Partridge *Alectoris rufa*

According to Arroyo et al. [12], this partridge was originally restricted to SW Mediterranean Europe, with the distribution range including the Iberian Peninsula, S. France, N. Italy and W. Mediterranean islands; about 250 years ago it was introduced and naturalized to the United Kingdom for hunting purposes. The release of hybrids of *A. chukar* x *A. rufa* and *A. rufa* x *A. graeca* into the original distribution area is certainly contributing to the potential genetic pollution of populations. Unscrupulous breeders regularly make breedings of *A. chukar* x *A. rufa* hybrids for the purpose of repopulation or, worse, introductions where the species never existed. Presently, it is very difficult to establish if natural populations that are completely unhybridized really exist, at least in the original Spanish distribution area. Given the current state of hybridization, it is somewhat difficult to still define this species as endemic; certainly, it is threatened by continued hybridization and is at risk of extinction due to the hunting management. This kind of anthropogenic hybridization coincides with Type 6 of Allendorf et al. [13], which occurs when any pure

populations remain, and conservation of hybrids should be considered the only option. Such introductions may cause loss of local adaptations and are causing the extinction of many taxa.

#### 3.2.2. Rock Partridge *Alectoris graeca*

According to Bernard-Laurent [14] the rock partridge is endemic to Europe, occurring in the Alps, the Apennines, Sicily and the Balkans, covering a distribution area certainly wider than 50,000 km$^2$. However, it is interesting to note that its populations have been separated into four distinct subspecies, one in the Balkans (*graeca*), one in the Alps (*saxatilis*), another in the Apennines (*orlandoi*) and finally a fourth on the island of Sicily (*whitakeri*); if we consider these populations separately, each of them can be considered truly endemic *sensu* Long et al. [11]. It is worth drawing attention to the fact that the Birds Directive also lists individual populations (=subspecies) deserving of special protection (e.g., *Alectoris graeca saxatilis* and *Alectoris graeca whitakeri* in the All. 1). I will return to this important concept later.

#### 3.2.3. Iberian Grey Shrike *Lanius meridionalis*

According to Giralt et al. [15], *Lanius meridionalis*, originally considered a species with European, African and Asian subspecies, has been treated as a separate species occurring only in the Iberian Peninsula and SE France. The distribution area is wider than 50,000 km$^2$, thus it cannot be considered strictly endemic.

#### 3.2.4. Italian Sparrow *Passer italiae*

Schneider and Sattler [16] consider *Passer italiae* as an European endemic with small range, occurring mainly in Italy, Sicily, Corsica, Crete and most of the smaller islands. In addition, according to Ait Belkacem et al. [17], *P. italiae* is widespread in North Africa. Furthermore, following Fulgione et al. [18], the song of *Passer italiae* shows a clinal latitudinal variation, abruptly breaking in the contact zone with *P. domesticus*. Hermansen et al. [19] found Sicilian sparrows much closer to *P. hispaniolensis* than the rest of *P. italiae*, but the birds analyzed for mtDNA had *P. domesticus* haplotypes. Besides, they found that *P. italiae* shares identical haplotypes with *P. domesticus* and *P. hispaniolensis* and does not form a distinctive clade. More recently, Runemark et al. [20] sequenced the genome from four island populations of the homoploid hybrid *Passer italiae* and reported that a variety of novel and fully functional hybrid genomic combinations are likely to have arisen independently on Crete, Corsica, Sicily and Malta, with differentiation in candidate genes for beak shape and plumage color. Following Runemark et al. [20], *P. italiae* populations differ in position along the axis of differentiation of the parent species, with Crete and Corsica closer to *P. domesticus* and Sicily and Malta closer to *P. hispaniolensis*. They found a significantly higher introgression of *P. hispaniolensis* in Sicilian and Maltese populations, compared with the populations from Crete and Corsica. They did not analyze North African specimens. The genetically very similar Sicilian and Maltese populations show a considerable difference in plumage; in accordance with these authors, the phenomenon may be interpreted as a result of repeated hybridization between the same parental species. In addition, in the last years, *P. hispaniolensis* immigrated from the Balkans to southern Italy, certainly increasing the rate of hybridization with *P. italiae*. Overall, these considerations do not allow *Passer italiae* to be considered an endemic species to Italy, North Africa and Crete. For these reasons, Massa et al. [21] have proposed considering the sparrow of southern Italy, Sicily and Malta as *Passer italiae* x *P. hispaniolensis*, and considering the hybrid origin of *P. italiae* and its distribution, they have proposed that it not be listed as Spec2, as proposed by BirdLife International [22], but possibly as Spec3, like *P. domesticus*. However, as reported above, Burfield et al. [1], not taking into account these new taxonomic acquisitions, moved *P. italiae*

to the rank of Spec1, also listing it as endemic. This kind of hybridization coincides with natural hybridization, the Type 3 of Allendorf et al. [13], where the reproductive success of hybrids is equal to that of parental species, which in turn are thought to be maintained by sexual selection.

### *3.3. Cases of Subspecies at High Risk of Extinction*

#### 3.3.1. Common Bottonquail *Turnix sylvaticus*

Presently, only a small population of common bottonquail *Turnix sylvaticus* survives in Morocco [23], and the status in the Mediterranean may be considered on the verge of extinction; in Europe in 2021 it was classified as 'Regionally extinct' (in 2015, it was 'Critically endangered') [24]. Violani and Massa [25], on the basis of the significant biometric differences observed between the Mediterranean subspecies *sylvaticus* and the other two geographically closer to it, *lepurana* from the sub-Saharan area and *dussumier* from Asia and Myanmar, considered that the hypothesis that these are separate species is sustainable, also in consideration of the long time interval since the last possible gene exchange. Even if we wanted to continue considering them as subspecies, i.e., isolated populations of a single species, for conservation purposes, the only thing to do would be to consider the Mediterranean subspecies *sylvaticus* as an endemic entity to be protected at all costs. Giving the remaining Mediterranean population, an endangered status could more easily activate conservation projects and possible breeding attempts for reintroduction to Europe. Making use of individuals from the populations of the other subspecies to increase the Mediterranean population would be neither ethically nor practically feasible.

#### 3.3.2. European Storm Petrel *Hydrobates pelagicus*

Two biometrically and genetically distinct subspecies of *Hydrobates pelagicus* are recognized, *H. p. pelagicus* in the Atlantic and *H. p. melitensis* in the Mediterranean, the latter characterized by a larger size and some different reproductive parameters [26–31]. The paleogeographic changes in the Strait of Gibraltar were likely the reason for the isolation of the Mediterranean population, which today, unlike the Atlantic one, shows a low genetic differentiation [31].

Martínez et al. [32], using stable isotopes, demonstrated that Mediterranean populations winter in the Sicilian Channel (Tunisian waters), and Lago et al. [33] showed that Maltese storm petrels remain in the Mediterranean all year round, even in winter, with the rare exceptions of individuals leaving the Mediterranean and moving into the Atlantic (see also Soldatini et al. [34]). However, this is not the rule; Militão et al. [35], indeed, using GLS, were able to demonstrate that at least some individuals of the population from Benidorm (Mediterranean Spain) winter in the Atlantic waters, from the Canary Islands to Iceland. It is possible that west Mediterranean populations still have some feeding relations with the Atlantic waters, but the mixing of Mediterranean and Atlantic populations during the breeding cycle has not been demonstrated. The Mediterranean population, being very small and decreasing overall, has reproductive parameters and a growth rate with a different strategy from the Atlantic one [29,36].

Mediterranean storm petrels are very philopatric, and the young almost always return to their natal site [37]; only a few cases of exchanges between colonies are known in the Mediterranean. It seems that contacts between the two taxa *H. p. melitensis* and *H. p. pelagicus* during the breeding season are absent. Indeed, of the numerous storm petrels ringed in the Atlantic colonies, there has never been a recovery within the Mediterranean. It can reasonably be assumed that between the two populations, Mediterranean and Atlantic, there is now a clear geographical separation.

Mediterranean populations are declining and critically threatened in their breeding sites due to human impact and predation by the black rat *Rattus rattus* and the yellow-legged gull *Larus michahellis* [38]. Generally, in the Mediterranean, this species is decreasing due to various anthropogenic causes (tourism boating, marine pollution, predatory action). Undoubtedly, the major limiting factor of the current distribution of the Mediterranean storm petrel is the presence of safe sites for reproduction in the islets, which is why the Mediterranean populations are in sharp decline. Although Tucker and Heath [39] considered the species as a whole 'localized', that is, with populations concentrated in a few sites, and included it in the Spec2 category, ten years later, BirdLife International [40] changed the status to 'safe' and moved the storm petrel to the NonSpecE category. The explanation for this lies in the fact that over the last few years, the knowledge and numerical estimates of the Atlantic populations have improved, which, unlike the Mediterranean ones, have shown a stable trend. Still, BirdLife International [22] in 2017 considered this species out of danger. Even if the species is already listed in Annex I of the Birds Directive and in the Berne Convention, the European Red List [41] considers it to be of least concern. However, of the 13 populations listed, only four have reliable population size estimates, and for the remaining eight, the trend is unknown [42].

Of course, this status cannot be shared on both biological and conservationist points of view, as it does not take into account an ongoing process of speciation, very likely concluded, namely the separation and isolation of Mediterranean populations; the genetic and morphological differences mentioned above allow *melitensis* to be considered as a valid Mediterranean taxon, and the absence of contacts or hybridization between the Mediterranean and Atlantic populations also allows them to be definitively considered as two distinct species, following the guidelines of Helbig et al. [43]. Therefore, Massa and Borg [44] proposed considering *Hydrobates melitensis* as a valid species, endemic to the Mediterranean, as also suggested by Sangster et al. [45], Robb et al. [46] and Harrison et al. [47].

However, independently from the taxonomic status as a species or subspecies, from a conservationist point of view, *melitensis* should be included in the Spec1 category of BirdLife International, i.e., a globally threatened taxon. As mentioned above, indeed, the Mediterranean populations are in decline and seriously threatened in their reproductive sites. The concept that should inspire protection cannot be taxonomic but simply biogeographical; an isolated population, consisting of a limited number of pairs, in decline, must be recognized as such officially. Otherwise, pursuing avenues for its protection will be increasingly complicated and have little success. According to Thomas [36], the Atlantic subspecies is estimated to be just over half a million pairs, while the Mediterranean subspecies should amount to less than 15,000 pairs. The Mediterranean storm petrel, in light of its proven differentiation from the Atlantic one, represents an important component of biodiversity, and the conservation of its populations certainly assumes a significant biogeographic value, which the scientific community cannot undervalue.

## 4. Concluding Remarks

Regarding terrestrial Macaronesian landbirds, according to the research of Recuerda et al. [48] on the chaffinch, a circuitous colonization pathway in Macaronesia occurred, from the Morocco to the Azores, followed by Madeira and finally the Canary Islands. According to the authors, species delimitation methods supported the existence of several species within the complex; they have recommended a taxonomic revision of the complex that takes into account its genetic and phenotypic diversity. In this context of taxonomic changes, after the publication of the HBW-BirdLife International Illustrated Checklist of the Birds of the World [49], where many subspecies have been raised to species level, Burfield

et al. [50] invited the global ornithological community to contribute to the updating and refinement of its species-level taxonomy, proposing that anyone with relevant information (e.g., on vocal or plumage differences) can contribute to challenge revisions made or to propose further splits or lumps. This proposal stems from the fact that environmental policy, at least ornithological policy, only recognizes the species level from a conservation perspective. If a taxon is recognized as a species, it can be evaluated, but individual subspecies are regrettably ignored, even if they have high biogeographic significance, for their unique traits.

I agree with Whiteley et al. [51]: successful genetic rescue inevitably increases genetic diversity. However, this is true only when genetic rescue is possible with individuals of the same subspecies. Subspecies is a taxonomic category consisting of populations differentiated from others of the same species by a set of inherited diagnostic characters and formed by the selective action of various factors. An isolated population goes through morphological and genetic differentiation, and in the event that it no longer comes into contact with the population of origin, this isolation leads to true speciation. The lack of gene flow between populations of different 'subspecies' is the necessary assumption for reproductive isolation to take place.

Why ignore this important aspect when attempting a species assessment at the European level? The purpose of an assessment is to try to identify all threats, both globally or locally, to individual populations of birds or other animals. To ignore this principle is to disregard the conservation priorities of species and their populations, coming to the absurd conclusion that highly threatened or endangered populations are treated as out of danger because they belong to widespread species, while others, whose taxonomic status is uncertain due to hybridization, lie among those with conservation priority. It is not the recognition of species status but that of the extinction risk of individual populations that should be used as the method for a comprehensive and inclusive assessment.

Before concluding, I would like to say a few words about some alternative concepts to that of subspecies or differentiated population. Ryder [52] coined evolutionarily significant units (ESU) as 'a subset of the more inclusive entity species, which possess genetic attributes significant for the present and the future generations of the species in question'. Entities defined as ESU arise from the accumulation of genetic differences through the various roles of evolutionary forces through time. They may be considered basic units of analysis, when evidence clearly indicates that a formally recognized species either fails to convey important evolutionary and geographical information or fails in delineating a natural entity [53]. ESU had both important and biological employ under the USA Endangered Species Act, the Australian Environment Protection and Biodiversity Conservation and the Canadian Species at Risk Act. However, over the years, there was a lack of agreement about the concept of ESU. Consequently, similar to the species concept, no definitive concept of ESU has prevailed so far. Moreover, Crandall et al. [54] proposed that ESU concepts might be replaced by a more holistic concept of species, consisting of populations with varying levels of gene flow evolving through drift and selection. Finally, Green [55] proposed the use of the Designatable Units (DU), a methodology adopted by the Committee on the Status of Endangered Wildlife in Canada; DUs may also be identified on the basis of demonstrations of genetic distinctiveness, similar to those used for the recognition of the ESU [55].

However, species and subspecies remain the only valid taxa considered by taxonomists.

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