

1 *Type of the Paper: Article*

2 **Assessment and monitoring protocols to guarantee** 3 **the maintenance of biodiversity in certified forest** 4 **exploitation: a validated methodology for FSC forests** 5 **in Southwestern Spain**

6 **Antonio J. Sánchez-Almendro¹, Pablo J. Hidalgo^{1*}, Rosario Galán², José M. Carrasco³, Javier**
7 **López-Tirado¹**

8 ¹ Departamento de Ciencias Integradas. Universidad de Huelva. Huelva. Spain; lauranto07@gmail.com;
9 pablo.hidalgo@dbasp.uhu.es; javier.lopez@dbasp.uhu.es.

10 ² FSC International Center GmbH. Adenauerallee 134, 53113 Bonn, Germany; r.galan@fsc.org

11 ³ Ence, Energía y Celulosa. Huelva. Spain; jcarrasco@ence.es

12
13 * Correspondence: pablo.hidalgo@dbasp.uhu.es; Tel.: +34 959 21 9886

14 Received: date; Accepted: date; Published: date

15 **Abstract:**

16 1) Sustainable forest management is of great importance in the European Union (EU), with the
17 Forest Stewardship Council playing a fundamental role in forest certification. This certification
18 forms the basis of the ecosystem conservation and improvement strategy in ENCE (the leading
19 company dedicated to the exploitation of eucalyptus in Spain). 2) A three-phase protocol
20 (identification of habitats, conservation status assessment and monitoring program), has been
21 developed, providing clear, objective criteria, particularly concerning FSC Principle 9, the primary
22 goal being the development and application of these objective criteria in the ENCE conservation
23 areas in Huelva. 3) The study encompasses 183 Forest Management Units covering 52,022 ha, with
24 a total of 11,847.45 ha being identified as High Conservation Values Areas. Having evaluated all
25 the criteria established by the assessment and monitoring protocols, a total of 91 patches were
26 considered priority candidates for more frequent inspection. 4) This study demonstrates that an
27 objective and reliable identification, assessment and monitoring methodology, with a proven high
28 degree of accuracy in the location and characterisation of interesting and representative habitats in
29 the region, can be implemented. Due to its objectivity, this strategy can be easily applied to other
30 European forest exploitation sites and possibly to other countries outside the EU.

31

32 **Keywords:** keyword 1; keyword 2; keyword 3 (List three to ten pertinent keywords specific to the
33 article; yet reasonably common within the subject discipline.)
34

35 **1. Introduction**

36 Commitment to sustainable forest management originated in the 1992 Rio de Janeiro Earth
37 Summit on Environment and Development. Then, in 1993, the second Ministerial Conference on the
38 Protection of Forests in Europe, held in Helsinki, defined sustainable forest management as the
39 administration and use of forests and forest lands in a manner and intensity that allows the
40 maintenance of their biodiversity, productivity, capacity for regeneration, vitality and potential to
41 perform important ecological functions, and so forth. More recently, this sustainable management

42 has been adopted by many European Union (EU) member states where forest certification has
43 become a fundamental mainstay [1].

44 During the Rio Earth Summit, a forum was held where the establishment of a
45 non-governmental, independent and international forest certification system that would promote
46 environmentally responsible and sustainable forest management was proposed. This paved the way
47 for the creation of the Forest Stewardship Council (FSC®), established in 1993 as an international
48 non-profit organization that pursues environmentally appropriate, socially beneficial and
49 economically viable forest management. FSC facilitates the sustainable production of wood and
50 non-timber forest products whilst maintaining the biodiversity, productivity and ecological
51 processes of the forest, without losing respect for the rights of the workers and the communities that
52 live and depend on these forests [2].

53 In addition to the production of eucalyptus pulp, ENCE, *Energía & Celulosa*, the main company
54 dedicated to the exploitation of eucalyptus in Spain, also generates renewable energy using forest
55 biomass [3]. Established in 1957 by the National Institute of Industry as a National paper mill
56 Company, in 2004 it became the first paper mill factory in the world to be certified by the two main
57 systems: PEFC (Program for the Recognition of Forest Certification Systems) and FSC® (Forest
58 Stewardship Council) [4]. Its national ecosystem conservation and improvement strategy [5] is
59 fundamentally based on the FSC standard, and is specifically focused on conservation areas – those
60 portions of the certified forest management unit for which conservation is the sole objective – which
61 include representative sample areas, conservation zones, protected areas, connectivity areas and
62 High Conservation Value Areas (HCVAs). The methodology developed to assess and conserve these
63 areas is based on three main phases: i) identification of the habitats; ii) conservation status
64 assessment and iii) monitoring program.

65 This methodology has been proven highly-effective in the evaluation, conservation and
66 monitoring of conservation areas within timber harvesting zones, and in helping ENCE achieve FSC
67 sustainable forest certification in Spanish forests [6]. It helps implement the FSC standard by
68 providing clear, objective criteria, particularly for FSC Principle 9 [2], that defines a realistic
69 evaluation and monitoring protocol applicable to any forest management system. Standardisation
70 should involve the use of unique and well-defined criteria for the evaluation of habitats, such as
71 present and potential area, minimum area and degree of isolation, number of characteristic species,
72 presence of exotic or endangered flora and presence of recent forest fires. These parameters are
73 relatively easy to evaluate following a pre-established standard scale. These monitoring criteria
74 should prioritise areas of particular interest, sensitivity, notable fragmentation, etcetera, that require
75 the establishment of a more frequent monitoring strategy.

76 Our primary goal has been the development and application of these objective criteria in the
77 ENCE conservation areas in the Spanish province of Huelva. This has allowed us to establish an
78 identification and evaluation protocol and to develop a periodic monitoring strategy to be
79 implemented over an indefinite period of time. The final goal is to test the effectiveness of this
80 protocol and to prove that it can be applied to other exploited forest sites anywhere in Europe.

81 2. Materials and Methods

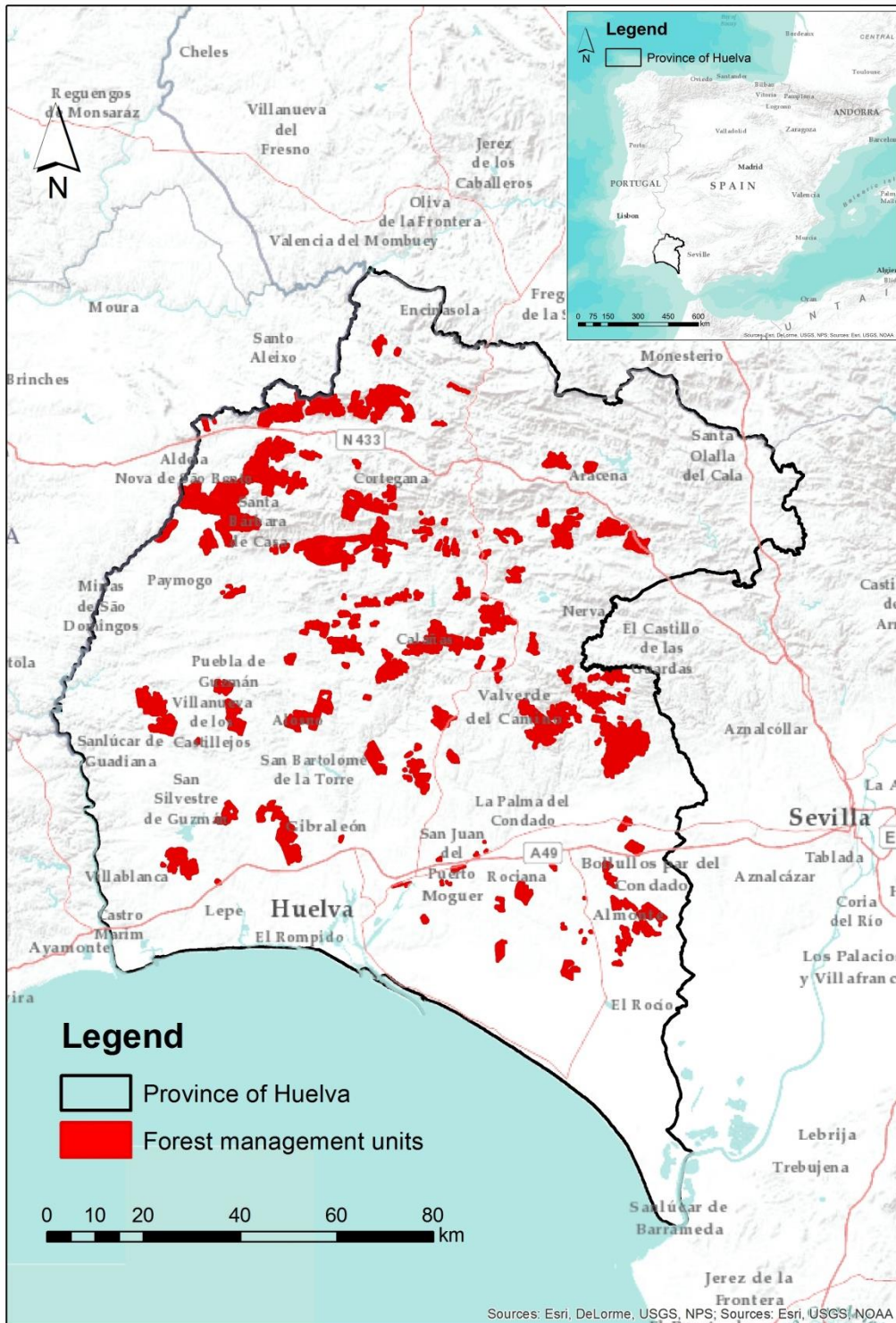
82 2.1. Area of Study

83 Figure 1 shows the distribution of the different ENCE Forest Management Units (FMUs) in the
84 province of Huelva. Most of the forests are found inland in areas of greater or lesser relief within the
85 Sierra Morena mountain range. Nevertheless, the presence of some patches in coastal areas and in
86 the surroundings of the Doñana Natural and National Parks is also significant.

87 Table 1 shows the synthesis of the area comprised of these management units. There are a total
88 of 183 Forest Management Units with an area of 52,022 ha, most of which are owned by ENCE. Of
89 the total area, 74.68% (38,850.41 ha) is, on the whole, planted with *Eucalyptus globulus*, for forest
90 exploitation purposes, with the remaining 25.32% (13,172.32 ha) covered by natural or semi-natural
91 vegetation formations. These latter constitute the conservation areas and include grasslands,

92 scrublands, rocky areas, forests or meadows of *Quercus* spp. Infrastructures such as firewalls or
93 reservoirs, among others, can also be found, though to a lesser extent. Figure 2 shows one of the
94 conservation areas that are generally comprised of river valleys, banks, rocks, meadows and
95 remnants of the original sclerophyllous forest, in the eucalyptus matrix.

96 Our study focuses on the 25.32% comprised of conservation areas where the identification,
97 assessment, maintenance and monitoring of HCVAs is mandatory in order to obtain FSC
98 certification.



99

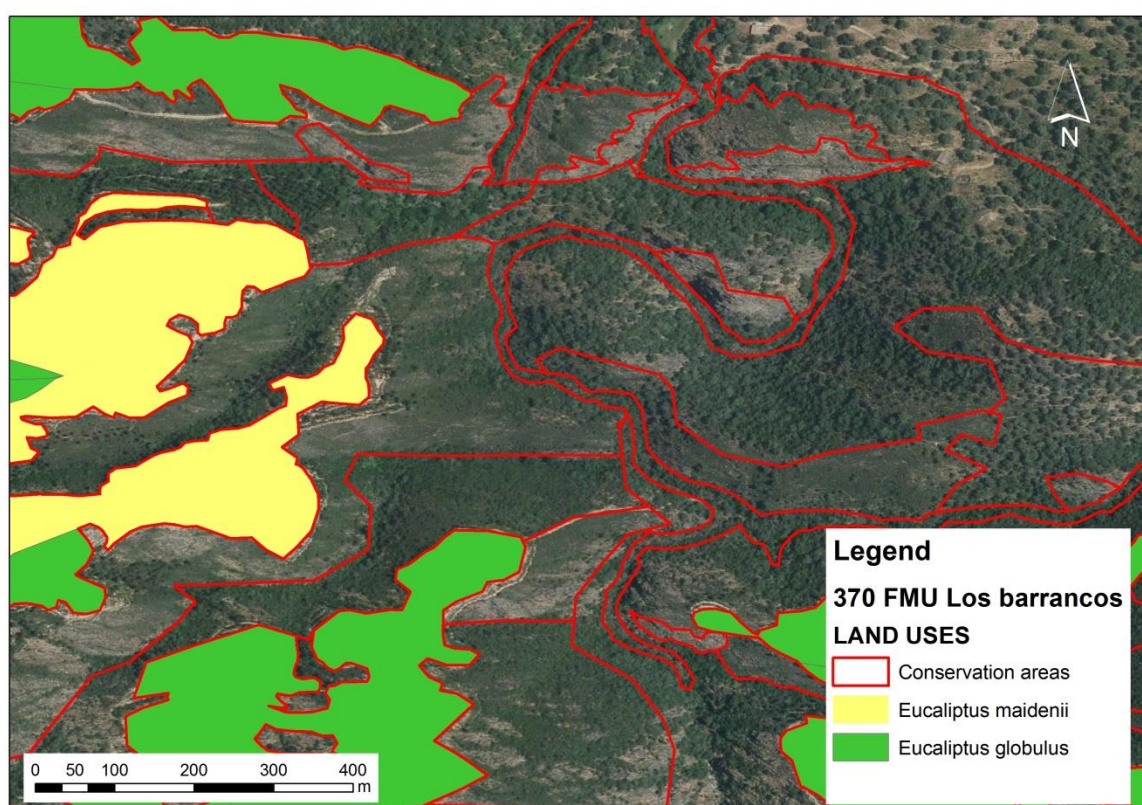
100

Figure 1. Location of the different ENCE Forest Management Units (FMUs) in the province of Huelva.

TOTAL AREA (ha)	FOREST EXPLOITATION (ha)	CONSERVATION AREAS (ha)
52,022.64	38,850.41 (74.68 %)	13,172.23 (25.32 %)
	<i>Eucalyptus globulus</i> 35,987.74	(HCVA: 8,119.78)
	<i>Eucalyptus maidenii</i> 1,349.1	(No HCVA: 5,052.45)
	<i>Eucalyptus camaldulensis</i> 806.86	
	<i>Eucalyptus dunnii</i> 123.62	
	<i>Eucalyptus saligna</i> 47	
	Other <i>Eucalyptus</i> spp. 124.71	

101
102

Table 1. Summary of the ENCE Forest Management Units in the province of Huelva, including the total area of each eucalyptus species and High Conservation Value habitat.



103

104 **Figure 2.** Digital ortophotograph of PNOA (Plan Nacional de Ortofotografía Aérea) with the shapefile of
105 the Forest Management Unit (FMU) "Los Barrancos", located in the municipality of Aracena (Nature Park
106 of Sierra de Aracena, Huelva, Spain). The polygons correspond to conservation areas in a matrix of
107 eucalyptus plantation, usually arranged into terraces.

108

109 2.2. Identification of HCVA in the conservation areas

110 Identification is carried out by means of the correspondence of the present habitats with those
111 listed in Annex I of the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) [7], which
112 includes all the Habitats of Conservation Importance (HCI) whose conservation requires the
113 designation of special areas. This list constitutes a European reference agreement resulting from a

114 long process of interpretation using the Interpretation Manual of European Union Habitats [8] and
115 phytosociology as the common methodological framework. When a conservation area encompasses
116 one or more habitats corresponding to the HCI listed in Annex I, it is considered a HCVA, as
117 outlined in the FSC standard. Where a conservation area lacks correspondence, and therefore has no
118 HCVA, it is still conserved according to the FSC standard, but have a lower monitoring frequency.
119 It is only HCVA that will proceed to the assessment and monitoring phases and will be subject to
120 more rigorous conservation measures. Our field study adopts the vegetation classification
121 methodology proposed by Braun-Blanquet [9] and the Mueller-Dombois & Ellenberg [10] approach
122 to the location of forest inventories. In general, all the conservation areas are sampled by means of
123 one or more of these phytosociological inventories, with phytosociological classification being based
124 on available bibliography [11, 12]. The field work was conducted every Spring (March - June) from
125 2012 to 2017. Following the identification of the inventoried vegetation, it was checked against the
126 HCI listed in the Habitats Directive and, if correspondence was found, considered to be HCVA. In
127 the exploration of the conservation areas, in addition to the vegetation samples, threatened and
128 invasive alien species are also identified. The threatened flora is defined in the applicable
129 environmental regulations. In this case, the catalogue included in DECREE 23/2012 regulates the
130 conservation and sustainable use of wild flora and fauna and their habitats in Andalusia [13], while
131 exotic flora is regulated by Royal Decree 630/2013 [14].

132 2.3. Assessment of the HCVA in the conservation areas

133 Once the HCI have been identified and considered as HCVA, the methodology for their
134 assessment is established by means of the Habitats Directive scale, which is easily applicable based
135 on the habitat's current state of conservation. Article 1 of the Habitats Directive 92/43/EEC [7] defines
136 the conservation status of a natural habitat according to the sum of the influences acting on it and its
137 typical species that may affect its long-term natural distribution, structure and functions as well as
138 the long-term survival of its typical species within the territory. A conservation status is deemed
139 'favourable' when its natural range and the areas covered within that range are stable or increasing,
140 the specific structure and functions necessary for its long-term maintenance exist and are likely to
141 continue to exist for the foreseeable future, and the conservation status of its typical species is
142 favourable. An 'inadequate-unfavourable' state is assigned for situations where a change in
143 management is necessary, but where the danger of extinction is not very high. Finally, an
144 'unfavourable-bad' conservation status corresponds to a habitat that is in serious danger of
145 disappearing (at least locally). Applying this scale, HCI in the conservation areas (HCVA) can be
146 evaluated according to a set of parameters related to the dynamism, structure and floristic
147 composition of the habitat:

- 148 a) Current and potential area within the conservation areas of each management unit.
- 149 b) Minimum area and degree of isolation.
- 150 c) Number of characteristic species identified in the inventories in relation to the original
151 description of the community.
- 152 d) Invasion of invasive alien flora: Degree of area affected and hazard level of the species
153 detected.
- 154 e) Presence of protected or threatened plants: Number of species and relative abundance.
- 155 f) Evidence of recent forest fires.

156 Each HCI in the conservation areas (HCVA) is assessed according to these parameters in each
157 Forest Management Unit. They can be 'favourable', 'inadequate-unfavourable' or 'unfavourable-bad'

158 depending on the corresponding criteria described in each parameter. A conservation area is
159 considered 'favourable' when 4 or more parameters (a, b, c, d, e, f) are deemed as such,
160 'unfavourable-inadequate' when only 2 or 3 meet the criteria, and 'unfavourable-bad' where there is
161 only 1 or indeed no favourable parameters. This process runs parallel to the identification schedule
162 and on completion of both, the results are submitted in a report to each Forest Management Unit.
163 This report forms the basis for future strategy and management. In addition to these values, forest
164 managers can establish several strategies necessary for the conservation of the HCVA's such as the
165 promotion and conservation of native vegetation; silvicultural activities to improve the forests,
166 eradication/control of invasive alien species; protection against grazing (fences); control/reduction of
167 erosion processes, improvement of infrastructures; landscape improvement; revaluation of singular
168 elements, and so forth.

169 *2.4. Monitoring of the HCVA's in the conservation areas*

170 Once assessed, the conservation areas can be maintained in their current status without any
171 management. Nevertheless, with a view to guaranteeing the maintenance or improvement of their
172 conservation status, the establishment of a monitoring protocol is recommended. This institutes a
173 regular inspection of the area, the frequency of which is dependent on the characteristics of the
174 habitat. Given the high number of management units and conservation areas, this protocol is
175 designed to prioritise the inspection of the most sensitive habitats which consequently have a greater
176 need for attention. In practical terms, this means an increase in the periodicity of the habitat
177 inspection. To prioritise the HCI in an HCVA, an assessment is conducted using seven parameters to
178 diagnose the most sensitive. The parameters considered as priorities for conservation, and therefore
179 monitoring, have been grouped as follows:

- 180 1. Presence of Priority Habitats for the Habitats Directive (marked with an * in Annex I).
- 181 2. Presence of threatened flora.
- 182 3. Presence of Invasive species.
- 183 4. Assessment of the state of conservation (resulting from the assessment phase).
- 184 5. Conservation actions (the proposals made in the assessment phase).
- 185 6. Fragmentation of the habitat: Analysis of the habitat fragmentation through the Conefor 2.6
186 software (<http://www.conefor.org/>). This methodology [15, 16], based on graph theory, allows
187 us to know the habitat availability and the state of fragmentation and isolation of each patch in
188 the global matrix and the possibilities for connection and dispersion of species. A value is
189 assigned to each habitat depending on its role in the connectivity. In this way, the software
190 clearly identifies those habitats which are particularly isolated.
- 191 7. Technical Assessment: Based on the presence of mature forests or singular or infrequent
192 elements in the area. The presence of these elements, often relict, means they are of great
193 interest in terms of conservation, and maintenance is key to guaranteeing adequate
194 management of the territory.

195 According to these parameters, each of the conservation areas is assigned a numerical value
196 (value 0: negative diagnosis or evidence of the parameter, and value 1: positive diagnosis or
197 evidence of the parameter). The data obtained by each HCI in the HCVA in each management unit
198 will be the final value used to establish the level of priority and the subsequent periodicity in the
199 monitoring phase. Table 2 shows the frequency of the inspection (monitoring) of each habitat
200 depending on the value of this assessment. Monitoring periods have been based on both the
201 Habitats Directive (Article 17), which establishes that every 6 years an evaluation of the status of the

202 HCI must be carried out, and on Law 42/2007, of Natural Heritage and Biodiversity (Article 47) [17]
 203 which establishes a 3-year evaluation period for areas with endangered species and a 6-year period
 204 for the remaining threatened species.

205

PRIORITIZATION LEVEL	ASSESSMENT VALUE	MONITORING FREQUENCY
1	≥ 4	3 years
2	2-3	6 years
3	0-1	Monitoring not necessary

206 **Table 2.** Prioritisation level and monitoring frequency depending on the assessment value.

207 3. Results

208 During this 5-year investigation (2012-2017), intense field studies have been conducted every
 209 Spring-Summer in order to coincide with the maximum representation of the flora and vegetation in
 210 the habitats. Assessment and monitoring phases ran simultaneously to the field studies. The final
 211 result, using digital cartography, is a detailed representation of all the conservation areas to scale
 212 1:1,000, with the associated inventories and assessment.

213 3.1. Identification

214 The exploration of 13,583.27 ha of conservation areas has allowed us to identify a total of 11,847.45
 215 ha of HCVA corresponding to HCI, representing 22.77% of the total area of the forests managed by
 216 ENCE (Table 3). The remaining areas not devoted to forest exploitation are covered by several types
 217 of vegetation, the majority being serial scrubs (rockroses and gorses), with pastures, pine plantations
 218 (*Pinus pinea* and *Pinus pinaster*) and abandoned eucalyptus plantations also frequently in evidence.
 219 As these types of vegetation are not included in Annex I of the Habitats Directive, they are not
 220 considered as HCVAs. Infrastructures such as firewalls, reservoirs, ruins, etc. are also excluded. In
 221 total, these non-HCVAs represent 1,735.32 ha (3.34%). A total of 19 different types of HCI in the
 222 HCVA have been identified (Table 3), the most widespread being heathlands, belonging to Group 4
 223 (temperate heath and scrub) of the Habitats Directive, followed by Group 9 (forests). These are also
 224 the most frequent (Table 3) although many of them are relicts with limited extension.

UE HABITAT TYPE	N	AREA (ha)
2 COASTAL SAND DUNES AND INLAND DUNES	4	
2260. <i>Cisto-Lavenduletalia</i> dune sclerophyllous scrubs	4	8,35
3 FRESHWATER HABITATS	15	97.87
3110. Oligotrophic waters containing very few minerals of sandy plains (<i>Littorelletalia uniflorae</i>)	10	69,12
3150. Natural eutrophic lakes with <i>Magnopotamion</i> or <i>Hydrocharition</i> — type vegetation	5	28,75
4 TEMPERATE HEATH AND SCRUB	123	4,981.56
4020. * Temperate Atlantic wet heaths with <i>Erica ciliaris</i> and <i>Erica tetralix</i>	3	1,18
4030. <i>European dry heaths</i>	120	4.980,38
5 SCLEROPHYLLOUS SCRUB (MATORRAL)	148	1,619.13
5110. Stable xerothermophilous formations with <i>Buxus sempervirens</i> on rock slopes	8	27,41
5330. Thermo-Mediterranean and pre-desert scrub	140	1.591,72
6 NATURAL AND SEMI-NATURAL GRASSLAND FORMATIONS	125	1,476.82
6220. * Pseudo-steppe with grasses and annuals of the <i>Thero-Brachypodietea</i>	48	650,63
6310. <i>Dehesas</i> with evergreen <i>Quercus</i> spp.	46	654,94
6410. Molinia meadows on calcareous, peaty or clayey-silt-laden soils (<i>Molinion caeruleae</i>)	16	41,95
6420. Mediterranean tall humid grasslands of the <i>Molinio-Holoschoenion</i>	15	129,3

8 ROCKY HABITATS AND CAVES	112	1,302.08
8220. Siliceous rocky slopes with chasmophytic vegetation	107	1.277,18
8230. Siliceous rock with vegetation of the <i>Sedo-Scleranthion</i> or <i>Sedo albi-Veronicion dillenii</i>	5	24,9
9 FORESTS	268	2,361.64
91B0. Thermophilous <i>Fraxinus angustifolia</i> woods	13	33,55
91E0. * Alluvial forestes with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (<i>Alno-Padion</i> , <i>Alnion incanae</i> ,	11	9,19
92A0. <i>Salix alba</i> and <i>Populus alba</i> galleries	13	10,53
92D0. Southern riparian galleries and thickets (<i>Nerio-Tamaricetea</i> and <i>Securinegion tinctoriae</i>)	140	715,51
9330. <i>Quercus suber</i> forests	40	1.056,91
9340. <i>Quercus ilex</i> and <i>Quercus rotundifolia</i> forests	51	535,95
TOTAL	795	11,847.45

225 **Table 3.** Area of the different types of HCI in the conservation areas of the Spanish province of Huelva and
 226 number of patches. Sorted by type and subtype as established in Annex I of the Habitats Directive. The
 227 habitats that appear with an asterisk (*) are considered priorities for the EU.

228 Table 4 shows the correspondence of each HCI with the phytosociological community described in
 229 the European Union Interpretation Manual. Group 4 - Heath, is primarily represented by a unique
 230 habitat type: 4030 - European dry heath. This is largely comprised of the rockrose-heathlands of the
 231 species *Erica australis*, which constitutes the subassociation *ericetosum australis* of the association of
 232 *Genisto hirsutae-Cistetum ladaniferi* and of *Ulici eriocladi-Cistetum ladaniferi*, though priority heaths
 233 (Group 4020 - temperate Atlantic wet heath) are relicts which can also found in the area. Group 5 -
 234 Sclerophyllous shrubs, is mainly represented by habitat 5330 - Thermo-Mediterranean shrubs, which
 235 are represented by the genus *Arbutus* (*Phillyreo angustifoliae-Arbutetum unedonis*), dominated by the
 236 species *Arbutus unedo*, *Erica arborea* or *Phillyrea angustifolia*. Other Thermo-Mediterranean scrublands
 237 are represented by *Asparago albi-Rhamnetum oleoidis*, with the xerophilous species *Olea europaea* var.
 238 *sylvestris*, *Pistacia lentiscus*, *Quercus coccifera*, *Myrtus communis*, and *Asparagus albus*. It is also possible
 239 to identify some chasmophytic communities of *Genistetum polyanthi*, or broomlands in degraded
 240 areas dominated by the species *Retama sphaerocarpa*. From Group 6 - Natural and Semi-natural
 241 Herbaceous Formations, a unique habitat, very abundant in the local agro-forestry farms,
 242 maintaining excellent semi-natural holm and cork-oak forests, is highlighted: 6310 - *Dehesas* with
 243 evergreen *Quercus* spp. This particular habitat is an open oak forest combined with natural pasture
 244 for livestock. This type of traditional exploitation is considered an excellent example of the
 245 sustainable use of natural resources, where domestic animals (porcine, ovine and bovine) are fed by
 246 acorns and pasture in a natural landscape of high environmental value. The most abundant
 247 vegetation in Group 9 is represented by Southern riparian galleries and thickets (92D0), which
 248 corresponds to the blackberry-oleander community (*Rubo ulmifolii-Nerietum oleandri*) in the area, a
 249 riparian scrubland very common in temporal or ephemeral streams.

UE CODE	COMMUNITY	N° PATCHES	AREA (ha)
2260	<i>Halimio halimifolii-Stauracanthetum genistoidis</i>	4	8.40
3110	<i>Scirpo fluitantis-Juncetum heterophylli</i>	10	69.10
3150	<i>Lemnetum minoris</i>	1	1.90
	<i>Lemnetum gibbae</i>	1	14.70
	<i>Callitricho stagnalis-Ranunculetum saniculifolii</i>	3	12.10
4020*	<i>Erico ciliaris-Ulicetum minoris</i>	3	1.20
4030	<i>Erico australis-Cistetum populifolii</i>	4	360.76
	<i>Genisto hirsutae-Cistetum ladaniferi</i> subas. <i>ericetosum australis</i>	25	1081.98
	<i>Halimio ocyroidis-Ericetum umbellatae</i>	41	1946.28
	<i>Ulici eriocladi-Cistetum ladaniferi</i> subas. <i>ericetosum australis</i>	50	1591.36
5110	<i>Lonicero hispanicae-Rubetum ulmifolii</i>	8	27.41
5330	<i>Retamo sphaerocarphae-Cytisetum bourgaei</i>	4	14.88

	<i>Genistetum polyanthi</i>	25	123.07
	<i>Phillyreo angustifoliae-Arbutetum unedonis</i>	52	742.09
	<i>Asparago albi-Rhamnetum oleoidis</i>	59	711.68
6220*	<i>Trifolio subterranei-Poetum bulbosae</i>	2	15.87
	<i>Pulicario paludosae-Agrostietum porretii</i>	5	25.27
	<i>Paronychio cymosae-Pterocphaletum diandri</i>	6	132.44
	<i>Gaudinio fragilis-Agrostietum castellanae</i>	7	20.08
	<i>Trifolio cherleri-Plantaginetum bellardi</i>	13	261.47
	<i>Dauco criniti-Hyparrhenietum sinaicae</i>	15	195.50
6310	Dehesa of <i>Quercus suber</i>	18	74.48
	Dehesa of <i>Quercus ilex</i>	28	580.46
6410	<i>Juncetum rugoso-effusi</i>	16	41.95
6420	<i>Junco rugosi-Ericetum andevalensis</i>	2	3.25
	<i>Holoschoeno-Juncetum acuti</i>	3	21.06
	<i>Trifolio resupinati-Holoschoenetum</i>	10	104.99
8220	<i>Polypodietum serrati</i>	2	4.03
	<i>Cheilanthe maderensis-Cosentinetum velleae</i>	10	88.37
	<i>Coincyo longirostrae-Dianthetum lusitani</i>	14	125.25
	<i>Asplenio billotii-Cheilanthe hispanicae</i>	39	616.98
	<i>Selaginello denticulatae-Anogrammetum leptophyllae</i>	42	442.55
8230	<i>Sedetum caespitoso-arenarii</i>	5	24.90
1B0	<i>Ficario ranunculoidis-Fraxinetum angustifoliae</i>	13	33.55
91E0*	<i>Scrophulario scorodoniae-Alnetum glutinosae</i>	11	9.19
92A0	<i>Crataego brevispinae-Populetum albae</i>	1	0.11
	<i>Nerio oleandri-Populetum albae</i>	1	0.39
	<i>Nerio oleandri-Salicetum pedicellatae</i>	1	0.58
	<i>Aro italici-Ulmetum minoris</i>	1	3.25
	<i>Salici pedicellatae-Populetum albae</i>	2	0.95
	<i>Viti viniferae-Salicetum atrocineriae</i>	7	5.25
92D0	<i>Polygono equisetiformis-Tamaricetum africanae</i>	3	1.83
	<i>Pyro bourgaeanae-Flueggeetum tinctoriae</i>	14	26.42
	<i>Rubo ulmifolii-Nerietum oleandri</i>	123	687.26
9330	<i>Myrto communis-Quercetum suberis</i>	11	361.65
	<i>Sanguisorbo agrimonioidis-Quercetum suberis</i>	28	693.94
9340	<i>Myrto communis-Quercetum rotundifoliae</i>	17	196.13
	<i>Pyro bourgaeanae-Quercetum rotundifoliae</i>	34	339.82

250 **Table 4.** Correspondence with the phytosociological community and EU code. Number of patches and
251 total area.

252 3.2. Assessment

253 Following the identification of all the HCVA's and their corresponding HCI, evaluation was
254 carried out for each management unit, considering the global conservation status of all the habitats
255 of the same category. This assessment is summarised in Table 5, which shows the majority to be
256 'favourable', with some classified as 'unfavourable-inadequate' due to the scant area of the patches
257 (criterion a) and degree of isolation (criterion b). In some cases, the inventories highlighted the
258 absence of some characteristic species (criterion c), possibly due to the degraded status of the plant
259 community. On only one occasion was a management unit classified as 'unfavourable-bad', with the
260 HCVA in question being a highly degraded and isolated patch of cork-oak forest (9330) that was
261 considered a relict representation of the area's climax vegetation. One group frequently classified as

262 'unfavourable-inadequate' was Thermo-Mediterranean and pre-desert scrub (5330), a very common
 263 scrubland in the conservation areas, though on many occasions represented as an isolated group of a
 264 few individuals. Of all the groups, Group 9 was deemed the most 'unfavourable-inadequate'.

UE CODE	FAVOURABLE	UNFAVOURABLE	
		INADEQUATE	BAD
2260	4	0	0
3110	10	0	0
3150	5	0	0
4020	2	1	0
4030	120	0	0
4030	8	0	0
5110	128	12	0
5330	48	0	0
6220	46	0	0
6310	15	1	0
6410	15	0	0
6420	107	0	0
8220	5	0	0
8220	13	0	0
8230	11	0	0
91B0	9	4	0
91E0	137	3	0
92A0	34	5	1
92D0	40	11	0

265 **Table 5.** Summary of the assessment of all HCVAs managed by ENCE in the province of Huelva. See table
 266 3 for EU code description.

267 3.3. Monitoring

268 Once all the HCVAs in all the forest management units have been identified and assessed, it is
 269 possible to apply a monitoring programme to determine the frequency of habitat inspection. This
 270 ensures that the most sensitive areas are identified and subsequently reviewed with greater
 271 frequency. With respect to the first criterion (1), three priority habitats were identified: 91E0*, 4020*,
 272 6620* (see Tables 2 and 3 for the description of the EU code and the corresponding phytosociological
 273 community). The first are Holartic riparian forests (*Alnus glutinosa*), the second relict Atlantic
 274 heathlands, very scarce in the area, and the third pseudo-steppe grassland represented by several
 275 communities (see Table 4). In relation to the second criterion (2), the following endangered species,
 276 listed in the national and regional regulations, were identified: *Armeria velutina* (4 patches),
 277 *Asplenium billotii* (45 patches), *Dianthus hinoxianus* (2 patches), *Erica andevalensis* (12 patches), *Isoetes*
 278 *durieui* (13 patches), *Loeflingia baetica* (1 patch) and *Spiranthes aestivalis* (1 patch). The third criterion
 279 (3) pertains to the presence of invasive alien species, the following of which were detected: *Acacia*
 280 *dealbata*, (4 patches), *Agave americana* (3 patches), *Ailanthus altissima*, (1 patch), *Cylindropuntia subulata*,
 281 (1 patch), *Opuntia dillenii*, (3 patches), *Opuntia maxima* (1 patch) and *Oxalis pes-caprae* (23 patches).
 282 Criteria four (4) and five (5) deal with the results of the assessment phase and the proposed
 283 strategies to improve the conservation status of the area. Over all, few patches were in need of
 284 action, which, when required, was mainly focused on reducing pressure from livestock. Following
 285 analysis by **Conefor 2.4** (criterion 6), a total of 52 patches have been considered as highly fragmented

286 belonging to the following HCI: 4020 (3 patches), 4030 (4 patches), 5110 (1 patch), 5330 (12 patches),
 287 91B0 (5 patches), 91E0 (2 patches), 92A0 (6 patches), 92D0 (7 patches), 9330 (6 patches) and 9340 (6
 288 patches). Criterion number seven (7) is the most conflictive, requiring the aid of a habitat expert. It
 289 was decided to include mature forests and singular and relict plant communities in this criterion,
 290 allowing for the inclusion of a total of 132 patches:

- 291 • Forests and edaphoclimatic communities:
- 292 - Thermo-Mediterranean Holm oak forests (*Myrtus communis-Quercetum rotundifoliae*), 17
 293 patches.
- 294 - Meso-Mediterranean Holm oak forests (*Pyro bourgaeanae-Quercetum rotundifoliae*), en 35
 295 rodales.
- 296 - Thermo-Mediterranean Cork oak forests (*Myrto communis-Quercetum suberis*), 11 patches.
- 297 - Meso-Mediterranean Cork oak forests (*Sanguisorbo hybridae-Quercetum suberis*), 28 patches.
- 298 - Riparian Alder forests (*Scrophulario scorodoniae-Alnetum glutinosae*), 11 patches.
- 299 • Singular or infrequent habitats in the study area:
- 300 - Riparian Red willow (*Viti viniferae-Salicetum atrocineriae*), 7 patches.
- 301 - Riparian Pedicel willow (*Nerio oleandri-Salicetum pedicellatae*), 1 patch.
- 302 - Heath (*Erico ciliaris-Ulicetum minoris*), 3 patches.
- 303 - Reed bed (*Juncetum rugoso-effusi*), 16 patches.
- 304 - Riparian elm forests (*Aro italici-Ulmetum minoris*), 1 patch.
- 305 - Mine heather (*Junco rugosi-Ericetum andevalensis*), 2 patches.

306

307 After evaluating all the criteria established in the monitoring protocol, a total of 91 patches from
 308 HCVAAs were considered as priority candidates for more frequent monitoring. Of these patches, 5
 309 obtained prioritisation level 1 with inspection proposed every 3 years, and 86 obtained prioritisation
 310 level 2 with inspection every 6 years (Table 6).

311

PRIORITIZATION LEVEL	ASSESSMENT VALUE	MONITORING PERIOD	NO PATCHES
1	≥ 4	3 years	5
2	2-3	6 years	86
3	0-1	Monitoring not necessary	704

312

313 **Table 6.** Prioritisation levels and number of patches of each level.

314

315 Classification of the most critical patches (level 1) is shown in table 7. It is interesting to point
 316 out that all relict Atlantic heaths (4020 UE code), present in three different forest management units,

317 were awarded the worst conservation status and therefore considered critically endangered. A
 318 thermo-Mediterranean holm oak forest (9340 UE code) and one of the three riparian thickets (92D0
 319 UE code) composed of tamarisk were also awarded an unfavourable conservation status, which
 320 shows serious deficiencies in conservation terms.

MANAGEMENT UNIT	HABITAT TYPE	COMMUNITY	CRITERIA FOR PRIORITIZATION							RESULT
			1	2	3	4	5	6	7	
316-EL BONAL	4020 *Temperate Atlantic wet heaths with <i>Erica ciliaris</i> and <i>Erica tetralix</i>	<i>Erico ciliaris-Ulicetum minoris</i>	1	0	0	0	1	1	1	4
334-PALLARES	4020 *Temperate Atlantic wet heaths with <i>Erica ciliaris</i> and <i>Erica tetralix</i>	<i>Erico ciliaris-Ulicetum minoris</i>	1	0	0	0	1	1	1	4
525-ALQUERIA DEL POZO	9340 <i>Quercus ilex</i> and <i>Quercus rotundifolia</i> forests	<i>Myrto communis-Quercetum rotundifoliae</i>	0	0	0	1	1	1	1	4
539-LA GIRALDA	4020 *Temperate Atlantic wet heaths with <i>Erica ciliaris</i> and <i>Erica tetralix</i>	<i>Erico ciliaris-Ulicetum minoris</i>	1	0	0	1	0	1	1	4
667-ALGARROBO	92D0 Southern riparian galleries and thickets	<i>Polygono-Tamaricetum africanae</i>	0	0	1	1	1	1	0	4

321 **Table 7.** Patches with prioritization level 1 and values assigned for each criterion.

322 4. Discussion

323 Forest exploitation always requires a compromise between profitability and conservation. In
 324 this fragile equilibrium, forest certification plays a fundamental role [18] serving as a tool by which
 325 consumers can make informed choices, opting for ethical, environmentally-friendly products from
 326 well-managed forests. Although there are many forest certification schemes, FSC is unique in that it
 327 operates at a global level. Furthermore, there is a strong consensus that FSC certified forests achieve
 328 higher levels of sustainable forest management compared to those using other certification
 329 procedures [19]. Though FSC certifies globally all types of forests and ownerships, it is often
 330 recommended for some countries, such as Spain, for public ownership, most likely due to its levels
 331 of cost and demand [1]. Nevertheless, for the case of private and small ownerships, FSC has several
 332 initiatives to support their certification, such as the creation of group certificates. In the case of
 333 ENCE, the company was formerly publicly owned, but has now become the first private forest
 334 exploitation company in Spain. Despite this change in ownership, they remain firmly committed to
 335 the conservation of the biodiversity of their heritage and to their customers, and this is reflected in
 336 the manner in which they implement their certification process.

337 This study demonstrates that a medium-large forest certification company can implement an
 338 objective and reliable methodology for identification, assessment and monitoring of biodiversity. In
 339 this case, the FSC principles are widely upheld and sustainable exploitation is compatible with the
 340 preservation of High Conservation Values Areas. The incorporation of this methodology into the
 341 global management of the ENCE forestry exploitation ensures the maintenance of biodiversity in the
 342 different forest management units. It is a lengthy process, the methodology requiring the aid of a
 343 group of experts (academic in this case). However, upon completion of the identification and
 344 assessment phases, the implementation of a monitoring strategy is easily developed using the
 345 techniques employed by the company, allowing the strategy to be maintained indefinitely.

346 The most time-consuming phase of this study was the identification of the habitats in the
347 conservation areas, requiring 2-3 days a week of field study over a 5-year period. Every single patch
348 was visited and inventory of the vegetation carried out when necessary. The identification of all of
349 the habitats and the subsequent establishment of their correspondence with the EU codes has led to
350 the creation of a new and powerful conservation tool in the shape of a highly-detailed digital map to
351 scale (1:1,000). The representation of the conservation areas in this way assists in the organisation of
352 silvicultural activities in a way which is compatible with the preservation of the natural habitat.
353 Furthermore, the information recovered during the identification phase is transcribed into a
354 technical report for each forest management unit, which is made available to all the workers
355 involved. In this way, the managers of each unit have the same detailed information of both the
356 eucalyptus plantation and the conservation areas. This equilibrium is a milestone in sustainable
357 development.

358 Governments (European, National and Regional) are responsible for the maintenance of the
359 biodiversity of their territories. The most ambitious initiative was that promoted by the European
360 Union (Habitats Directive) with the aim of creating a coherent ecological network, known as Natura
361 2000 [20]. This network is already in operation and has proven to be an excellent global conservation
362 strategy. Forests in Natura 2000 can be managed with a view to achieving multiple functions, such as
363 timber production, hunting, and recreation, in addition to nature protection [21]. Nevertheless, it
364 was recently reported that more efforts are needed in order for this network to reach its full potential
365 [22]. The compatibility between forest exploitation and conservation proposed by this network
366 encourages us to use their methodology for the identification and classification of the High
367 Conservation Value Areas considered in Principle 9 of FSC forest certification. This classification has
368 been widely applied to all the natural habitats of the member states with a high degree of
369 replicability everywhere it has been implemented. This procedure has allowed us to identify
370 numerous different habitats, many of them endangered or relict, with high accuracy, and with the
371 full backing of the European Environmental Agency (EEA). We have identified a wide range of the
372 habitats listed in Annex 1. Indeed, with the exception of groups 1 (coastal and halophytic habitats)
373 and 7 (raised bogs and mires and fens), which are logically absent from this geographical area, at
374 least one representation of the rest of the habitat groups listed in Annex 1 have been detected. It is
375 interesting to note that the habitats most highly represented in the conservation areas are those of
376 Group 9 (Forests), with a total of 6 subtypes. This group is the most striking in terms of ecological
377 succession because it is representative of the woodland vegetation native to the territory (in both
378 riparian and dry land areas). In total, 19 subtypes of EU habitats, represented by 48 different
379 phytosociological communities, have been detected. This result shows a higher level of biodiversity
380 than the most representative protected area in the study zone, the Natural Park of Sierra de Aracena
381 y Picos de Aroche, which has 186,795.16 ha and only 16 subtypes [23]. With respect to priority
382 habitat, we have found a total of 8 out of 48 communities, representing one sixth of the total (16.6%).

383 In conclusion, despite the highly time-consuming nature of the process, our methodology has
384 demonstrated a high degree of accuracy in the location and characterisation of interesting and
385 representative habitats in the conservation areas, as evidenced by the discovery of new localities of
386 endangered flora [24, 25, 26] one of which (*Narcissus scaberulus*) is listed in Annex II of the Habitats
387 Directive. Furthermore, it is the first recorded in Western Andalusia.

388 The assessment phase, using 6 objective criteria (a-f), also proved a successful tool in the
389 evaluation of the conservation status of the habitats, being both easy and quick to apply following
390 identification of the habitat. The proposed scale being the same as that used in habitat assessment by
391 the EU ensures that our results are compatible with theirs. However, our approach takes things a
392 step further by evaluating the HCI by Forest Management Unit rather than by Special Conservation
393 Area (SCA, the areas included in the Natura 2000 Network) as per the EU approach. This results in a
394 level of detail that aids in the management and maintenance of the biodiversity with even greater
395 accuracy. The application of this methodology has revealed that the conservation status of the areas

396 under study was higher than initially expected. Fortunately, few HCVAAs were assessed as
397 'unfavourable-bad'. Group 9, on the whole highly representative of the native Mediterranean forests
398 [27] was the worst evaluated, with 24 HCVAAs in the different FMUs classified as 'unfavourable'.
399 These relict forest formations are only maintained in a small number of enclaves, the degree of
400 isolation of these patches and the intensity of edge-effect leading to a deficient conservation status.
401 In any case, the effectiveness of the proposed methodology is evidenced by its ability to identify
402 these critical areas, which will subsequently be submitted for a priority re-evaluation process in
403 order to improve their conservation measures.

404 The methodology tested in the monitoring strategy utilised a coherent and straightforward set
405 of criteria (1-7) using all the information obtained in the previous steps. All priority habitats,
406 endangered and invasive alien species and isolated patches were detected and considered in the
407 evaluation. The results highlighted those critical patches in need of more frequent inspection in
408 order to meet the requirements of FSC certification. Using this strategy, it is possible to maintain
409 control of all conservation areas and to reverse the negative conservation status of the most critical.
410 With the aim of considering additional objective criteria, the 7th criterion (technical assessment)
411 proved an interesting contribution to the final monitoring program. The inclusion of this criterion
412 meant that even the most singular and representative habitats were considered, even if they had
413 been positively evaluated in the assessment phase, thus giving these areas the significance they
414 deserve.

415 Furthermore, this methodology has been included in the testing phase of the newly-released
416 FSC Ecosystem Services Procedure [28]. This procedure provides a series of steps to demonstrate the
417 positive impacts of FSC-certified forest management on ecosystem services. Through the
418 identification and assessment of the conservation areas, the described methodology played a crucial
419 role in demonstrating the positive impact of ENCE's certified forest management on the
420 conservation of biological diversity. The methodology was useful to measure several of the outcome
421 indicators needed to prove the sufficiency of the conservation areas for the maintenance of the
422 biodiversity, and helped implement the Ecosystem Services Procedure. The certification body
423 participating in the pilot test agreed as well that this methodology was useful to demonstrate the
424 positive impact that FSC-certified forest management has on ecosystem services, particularly on the
425 conservation of biodiversity in this case.

426 5. Conclusions

427 The objective of this study has been broadly reached. The methodology guarantees the
428 identification, maintenance and improvement of biodiversity in forest exploitation, and helps meet
429 the sustainable forestry requirements established by FSC.

430 Due to its objectivity, this strategy can be easily applied to other forest exploitation sites in
431 Europe. In order to establish whether this methodology could be applied to countries outside
432 Europe, compatibility with other conservation strategies should be tested. In any case, the proposed
433 strategy could at least serve as a preliminary working scheme in those countries.

434

435 **Author Contributions:** Conceptualization, Rosario Galán; Funding acquisition, Pablo J. Hidalgo; Investigation,
436 Antonio J. Sánchez-Almendro, Pablo J. Hidalgo, José M. Carrasco and Javier López-Tirado; Project
437 administration, José M. Carrasco; Resources, José M. Carrasco; Supervision, Pablo J. Hidalgo; Validation,
438 Rosario Galán and José M. Carrasco; Writing – original draft, Antonio J. Sánchez-Almendro; Writing – review &
439 editing, Pablo J. Hidalgo and Javier López-Tirado.

440 **Funding:** This research was funded by ENCE, Energía y Celulosa by the contract with the Department of
441 Integrated Sciences, University of Huelva entitled: Identificación y Caracterización de Hábitats de Interés
442 Comunitario en los Montes Gestionados por Ence, Energía y Celulosa en la Zona Sur, fases I, II y III.

443 **Acknowledgments:** Authors are grateful to overseers of the Forests Management Unit for their help in
444 accessing to the forests and natural areas.

445 **Conflicts of Interest:** Declare conflicts of interest or state “The authors declare no conflict of interest.”

446 References

447

- 448 1. Gomez-Zamalloa, M. G.; Caparros, A.; Ayanz, A. S. 15 years of Forest Certification in the European Union.
449 Are we doing things right? *Forest Syst* **2011**, *20* (1), 81-94.
- 450 2. Forest Stewardship Council A.C. FSC Principles and Criteria for Forest Stewardship (FSC-STD-01-001),
451 **2015**. <https://ic.fsc.org/en/what-is-fsc-certification/principles-criteria>.
- 452 3. Vegas, MJH. Largest forest biomass fired 50Mwe power plant in south of Europe. 22nd European
453 International Biomass Conference-Setting the Course for a Biobased Economy, Hamburg, GERMANY
454 JUN 23-26; Hoffman C., Baxter D., Maniatis K., Grassi A., Helm P. Eds. 2014; 1706-1710.
- 455 4. Ence Energía y Celulosa. Annual Report 2010. Ence, Energía y Celulosa, **2010**.
456 <http://asp-es.secure-zone.net/v2/index.jsp?id=994/3339/7165&startPage=14>.
- 457 5. Sánchez-Hernando, L.J. ENCE: una evolución coherente con su pasado más inmediato. *Foresta* **2011**, *50*,
458 74-75.
- 459 6. FSC Spain. Spanish National Forest Stewardship Standard for FSC certification (FSC-STD-ESP-01-2006),
460 **2006**. <https://es.fsc.org/preview.fsc-std-esp-2006-01-esp-2-0.a-135.pdf>
- 461 7. Habitats Directive, 1992. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural
462 habitats and of wild fauna and flora.
- 463 8. European Commission. Interpretation Manual of European Union Habitats. EUR 28. April 2013. DG
464 Environment, Nature ENV B.3, **2013**, pp. 144.
- 465 9. Braun-Blanquet, J. *Fitosociología*. 2^a ed. Traducción castellana. Ed. Blume. Madrid, 1979. ISBN
466 9788472141742.
- 467 10. Mueller-Dombois, D.; Ellenberg, H. *Aims and Methods of Vegetation Ecology*. Ed. John Wiley & Sons. Inc.,
468 USA, 1974; ISBN 9780471622901.
- 469 11. Mucina et al. Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte,
470 lichen, and algal communities. *Appl Veg Sci* **2016**, *19* (Suppl. 1), 3–264.
- 471 12. Rivas-Martínez, S.; Fernández-González, F.; Loidi, J.; Lousã M.; Penas, A. Syntaxonomical checklist of
472 vascular plant communities of Spain and Portugal to association level. *Itinera Geobotanica* **2001**, *14*, 5-341.
- 473 13. Decree 23/2012 February the 14th, regulates the conservation and sustainable use of wild flora and fauna
474 and their habitats in Andalusia. Boletín Oficial de la Junta de Andalucía de 27 de marzo de 2012, núm. 60,
475 pp. 114 a 163. <http://www.juntadeandalucia.es/boja/2012/60/d6.pdf>.
- 476 14. Royal Decree 630/2013, August the 2nd, regulates the Spanish catalog of invasive exotic flora. Boletín
477 Oficial del Estado núm. 185, de 3 de agosto de 2013, pp. 56764 a 56786.
478 (<https://www.boe.es/boe/dias/2013/08/03/pdfs/BOE-A-2013-8565.pdf>).
- 479 15. Pascual Horta, L.; Saura, S. Integración de la conectividad ecológica de los bosques en los instrumentos de
480 planificación forestal a escala comarcal y regional. Propuesta metodológica y nueva herramienta de
481 decisión. *Revista Montes* **2008**, *94*, 31-37.
- 482 16. Saura, S.; Rubio, L. A common currency for the different ways in which patches and links can contribute to
483 habitat availability and connectivity in the landscape. *Ecography* **2010**, *33*, 523-537.
484 <https://doi.org/10.1111/j.1600-0587.2009.05760.x>
- 485 17. Law 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad.
486 <https://www.boe.es/boe/dias/2007/12/14/pdfs/A51275-51327.pdf>
- 487 18. Ozinga, S. Behind the logo: an environmental and social assessment of forest certification schemes. Forests
488 and the European Resource Network, Moreton-in-Marsh, Gloucestershire, UK, 2001, pp 1-64.
- 489 19. Clark, M. R.; Kozar, J.S. Comparing sustainable forest management certifications standards: a
490 meta-analysis. *Ecology and Society* **2011**, *16*(1): 3 [online] URL:
491 <http://www.ecologyandsociety.org/vol16/iss1/art3>
- 492 20. European Commission. Managing and Monitoring of the Natura 2000 Network. Science for Environment
493 Policy, **2012**, Thematic issue 32.
- 494 21. European Commission. Natura 2000 and Forests. Part I-II. Technical Report, **2015**, 088.

- 495 22. European Court of Auditors, 2017. More efforts needed to implement the Natura 2000 network to its full
496 potential. Special Report. 68 pp. EU Bookshop (<http://bookshop.europa.eu>).
- 497 23. Natura 2000–STANDARD DATA FORM. 2017. Sierra de Aracena y Picos de Aroche.
498 <http://natura2000.eea.europa.eu/>.
- 499 24. López-Tirado, J.; Núñez Álvarez, A.; Carmona Ruiz M.I.; Hidalgo P.J. On the presence of *Narcissus*
500 *scaberulus* Henriq. (Amaryllidaceae) in western Andalusia (Spain). *Flora Montiberica*, **2016**, *63*, 101-102.
- 501 25. López-Tirado, J.; Sánchez-Almendro A.J.; Carrasco-Antelo, J.M.; Hidalgo, P.J. New chorologic
502 contributions to the endangered *Isoetes durieui* Bory (Isoetaceae, Pteridophyta) in the province of Huelva
503 (Andalusia, Spain). *Acta Bot Malacitana*, **2015**, *40*, 274-276.
- 504 26. López-Tirado, J.; Hidalgo, P.J. A new locality for the endangered species *Ceratocarpus hererocarpa* Durieu
505 (Papaveraceae) to Spain and its syntaxonomical characterization. *Acta Bot Malacitana*, **2014**, *39*, 248-253
- 506 27. Costa, M.; Morla, C.; Sainz, H. Eds. *Los bosques ibéricos: una interpretación geobotánica*. Ed. Planeta. Barcelona,
507 1997. ISBN 9788408058205.
- 508 28. Forest Stewardship Council A.C. Ecosystem Services Procedure: Impact Demonstration and Market Tools
509 (FSC-PRO-30-006), **2018**. <https://ic.fsc.org/en/what-is-fsc/what-we-do/ecosystemservices>.

510



© 2018 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license

513 (<http://creativecommons.org/licenses/by/4.0/>).