Evaluation of the state of conservation of shallow lakes in the province of Leon (Northwest Spain) using botanical criteria

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ABSTRACT

The floristic richness of the aquatic and hygrophytic vegetation of 27 permanent and temporary small lakes located in the León province was analyzed. The evaluation of these wetlands was carried out specifying their significance at a European, national and regional level. The main factors related to species richness were size of the water body and alterations due to pollution and shore degradation. Samplings in 1981 and 1994 were compared. Highly significant differences in genera and species richness were found between years in all lakes. The richness of hygrophytic flora was much larger in the latter sampling. This was related to large interannual variations in mean water levels. Botanical criteria for assessing shallow lake ecological importance use indices based on the abundance of hydrophytes and on floristic richness of sites. We conclude that four of the 27 lakes and wetlands studied here are of European interest, while 10 are of national significance.

Key words: Macrophytes, species richness, temporary lakes, shallow lakes, conservation.

RESUMEN

Se analiza la riqueza florística de la vegetación acuática e higrófila de 27 formaciones palustres permanentes o con ritmos de inundación temporal en el cuadrante suroriental de la provincia de León, y se realiza la valoración de estos humedales, especificando su significado en los contextos europeo, nacional y regional. Los factores que parecen estar relacionados con la riqueza de especies y de géneros en las lagunas son: su extensión, y las alteraciones que experimentan por contaminación y degradación de la orilla. Se comparan los resultados obtenidos en muestreos efectuados en 1981 y 1994. Cuando se considera la riqueza de géneros y especies de cada laguna las diferencias son muy significativas, aumentando especialmente la riqueza de la flora higrófila en el muestreo más reciente debido probablemente a las variaciones interanuales de la disponibilidad de agua. De acuerdo con la valoración de las lagunas según criterios botánicos, que utilizan índices basados en la importancia de los hidrófitos y en la diversidad florística de cada enclave, y que reflejan la madurez del sistema y grado de conservación, se deduce que tienen importancia en el contexto europeo 4 lagunas y 10 en el ámbito nacional.

Palabras clave: Macrófitos, riqueza de especies, lagunas temporales, conservación.

INTRODUCTION

The number of references to temporary waters is not in accord with their widespread ocurrence, ecological importance and limnological interest (Williams, 1987). In the southeast of León there is a number of water bodies, usually shallow, fostered by overland water inflows and groundwater flows. These water bodies are rarely permanent, though water is retained enough time for macrophytic communities to grow. Such communities were described by Fernández Aláez *et al* (1984, 1986a, 1986b, 1988) from a sampling carried out in 1981. Unusual weather patterns in the past years and intensification of agriculture in recent decades have adversely affected many shallow

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lakes in León. Despite this, recent studies (Casado & Montes, 1995) refer to shallow lakes with scarce mineralization in SE León as well preserved. The objective of the present paper is to document changes in the aquatic and marginal flora and vegetation of these water bodies, evaluating changes between surveys.

Classically, Spanish wetlands have been evaluated on the basis of their avifaunal richness (Amat *et al.*, 1985). Cirujano *et al*. (1992) have recently developed a methodology which makes use of macrophytes in lakes and wetlands as indicators of biological significance. In the assessment of small lakes in León, we have used these botanical criteria, comparing the biological significance of lakes and wetlands in León and in other areas of Spain.

STUDY AREA

Water bodies are located in the southeast quarter of the province of León, an extension of the Central Spain plateau and of the "Tierra de Campos". These water bodies are situated at either side of the river Esla. To the west, the "Páramo Leonés" area comprises 10 of the 27 lakes selected in this study. The remaining lakes are to the east of the river, in an area next to Tierra de Campos, to the southeast. The north of this area is called "Comarca del Payuelo" (Fig. 1).

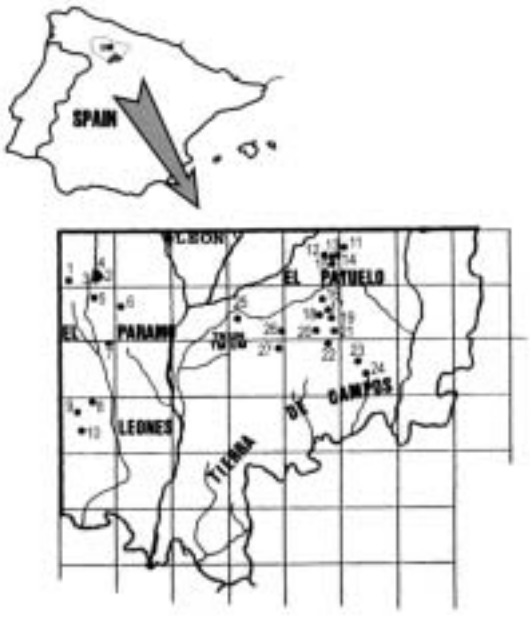

Figure 1. Geographical location of lakes studied in southeast León. Codes used correspond to those in Table 1. *Localización geográfica de las lagunas estudiadas en el sureste de León. La numeración utilizada se corresponde con la de la Tabla 1*

The dominant lithology of the river Duero basin in León consists of low-thickness post-Tertiary deposits ("rañas"and alluvial terraces) which surface-cover the great Tertiary detrital deposits.

Water bodies are highly dependent on "rañas" aquifers and, more precisely, on underground flow of the Esla-Valderaduey region (Duch *et al*., 1995).

Most of these lakes constitute recharge areas with edaphic or lithological impermiability, where lineal discharges of short, poorly-mineralized flows which are independent of the regional aquifer may occur.

Climate features of the study area are those typical of the northern plateau: cold, usually rainy, winters and hot summers with low rainfall. These characteristics result in significant summer drought.

Table 1 shows the values of the variables chosen in the morphological description of the lakes, as well as the water permanence. These values may be useful in explaining the dynamics of their biological features. Annual and interannual fluctuations are a typical characteristic of lakes in semi-arid regions and determine the community composition.

METHODOLOGY

Lakes selected for this study are largely those sampled by Fernández Aláez in 1981 (Fernández Aláez, 1984). The characterization was carried out by means of qualitative sampling between June and July 1994. The aim of this paper is to assess likely changes in the flora of lakes in SE León occurring in the 13-year period between the two sampling efforts. Differences in species rich-

Tabla 1. Lakes studied in southeast León. Geographical UTM coordinates, morphometric characteristics and an index of water permanence are indicated. *Lagunas estudiadas en el sureste de León, indicando su situación geográfica y sus características morfométricas y de permanencia del agua.*

LAKE	COORDINATES (UTM)	AREA (Ha)	PERIMETER (Km)	SHORE-LINE DEVELOPMENT(a)	PERSISTENCE DEPTH(cm)	MAXIMUM (b)
1. VILLADANGOS	30TTN721114	9.18	1.15	1.07	150	5
2. CHOZAS (A)	30TTN774114	2.71	0.65	1.11	110	3
3. CHOZAS (B)	30TTN772113	5.37	1.11	1.35	200-250	5
4. CHOZAS (C)	30TTN772116	5.71	1.00	1.18	100-150	4
5. LAG. DEL MONTE (*)	30TTN790074	0.57	0.27	1.00	100	2
6. REY	30TTN807053	2.50	0.60	1.07	150-200	4
7. LA MAYOR	30TTN788998	0.64	0.30	1.06	100	3
8. STA CRISTINA	30TTM764883	0.45	0.82	1.08	150-200	4
9. EL MELGAN (*)	30TTM741871	2.15	0.66	1.27	150	4
10.ZOTES DEL PARAMO	30TTM744841	1.33	0.54	1.32	200	5
11. VILLAVERDE LA CH.	30TUN205163	1.76	0.50	1.06	130	4
12. VALDEPOLO	30TUN175151	1.20	0.40	1.03	100	4
13. LAGUNETA 1	30TUN191146	0.41	0.29	1.28	70	3
14. LAGUNETA 2	30TUN192146	0.20	0.16	1.01	60	3
15. SENTIZ	30TUN199141	4.67	1.15	1.50	180	5
16. MAYOR (*)	30TUN167072	3.13	0.65	1.04	80	2
17. DEL REDOS	30TUN176052	0.98	0.47	1.34	180	4
18. EL ESPINO	30TUN166046	1.74	0.55	1.18	80-100	3
19. EL ESTORRUBIO	30TUN186041	0.83	0.35	1.08	150	2
20. LA CAMPANA (*)	30TUN169014	0.72	0.32	1.06	120	2
21. EL SURCO	30TUN192011	0.20	0.15	0.95	100	3
22. EL BURGO RANERO	30TUM174993	1.38	0.42	1.01	100	4
23. BERCIANOS R. C.	30TUM233953	0.60	0.35	1.27	100-150	5
24. LAGUNA GRANDE	30TUM246933	1.19	1.62	1.13	150-200	4
25. LA BALASTRERA	30TUN025038	2.67	0.80	1.38	100-150	3
26. VILLAMARCO	30TUN099015	1.68	0.50	1.09	100-150	3
27. LA SECA	30TUM088974	3.03	0.67	1.09	150-200	3

(a) Shore - line development quotient $= \dfrac{\text{Perimeter (m)}}{2\sqrt{\pi\ \text{Area (m}^2\text{)}}}$

(b) 1.- Ephemeral (1-2 months)
2.- Very temporary (2-6 months)
3.- Temporary (6-9 months)
4.- Semipermanent (9-12 months)
5.- Permanent

(*) Lakes which were not included in the 1981 study (FERNÁNDEZ ALÁEZ, 1984)

ness between both studies were analysed using a t-test for dependent samples after checking that data were normal ($p<0.05$).

To evaluate the species of aquatic flora we used the I_T index proposed by Cirujano *et al.* (1992). This index takes values from 2 to 10 and considers three aspects of hydrophytes, i.e. Statewide frequency, state of preservation in the study area and importance with respect to the European flora. An index for evaluation of wetlands (I_H)

has been proposed by Cirujano *et al*. (1992), with values varying between 1 and 10. The wetland index I_H is the half-sum of the floristic index , and the diversity index I_D. The floristic index I_F is calculated from the I_T of the n hydrophyte species at each site. The diversity index I_D considers the floristic richness of the lake (hydrophytes and hygrophytes). When applying the I_D index to the lakes in León, the valuation scale has been modified (I_D') by increasing the number of species belonging to every class: 2 (1 to 5 species), 4 (6 to 12), 6 (12 to 20), 8 (21 to 40) and 10 (over 40). To a certain extent, this avoids overestimating the interest value of our lakes, because most of them present in excess of 20 species.

RESULTS

Characteristics of vegetation. Floristic richness

The macrophytic vegetation of wetlands in southeast León is very rich in species. A total of one hundred and one species were recorded, considering both the typically aquatic flora (23 species) and the hygrophilous plants (78 species), including several helophytes. This floristic richness comprises 57 genera, of which 13 genera are hydrophytes and 45 are hygrophytes (genus *Ranunculus* is represented in both groups) (Table 2). Among the most frequent species are *Myriophyllum alterniflorum, Polygonum amphibium* and *Ranunculus peltatus*. The hygrophylic vegetation (i.e. helophytes and other marginal species closely linked with the aquatic environment) is also rich in species. *Scirpus lacustris* subsp. *lacustris*, which prefers permanent or semipermanent waters, was the most important species among the great helophytes in the lakes studied. Its presence in temporary water bodies suggests these systems may have been more permanent in the past. Small helophytes were more frequently found than great helophytes. The species with larger biomass were *Eleocharis palustris, Antinoria agrostidea, Glyceria fluitans* and *Alopecurus geniculatus*. Other, marginal species found were *Mentha pulegium, Mentha cervina, Galium palustre, Polypogon maritimus, Hordeum marinum, Pulicaria paludosa* and *Juncus articulatus*, contributing to the species richness of the hygrophylic flora in these wetlands.

Tabla 2. Richness of genera and species of hydrophytes and hygrophytes across lakes in SE León (Spain). Richness values obtained in 1994 and 1981 are compared. *Riqueza de géneros y especies de hidrófitos e higrófitos. Se comparan los resultados obtenidos en 1994 y 1981.*

	number of genera			number of species	
	hydro phytes	hygro phytes		hydro phytes	hygro phytes
1994	13	45	1994	23	78
1981	13	44	1981	24	87

Floristic richness of aquatic plant species of selected lakes in León was compared to that in the province of Cuenca (Cirujano, 1995) and also to the overall of Spain (Table 3).

A 38.2% of total angiosperm and charophyte genera, and 17.7% of the total number of species known to be present in Spain were recorded in León. Also in León, 72.2 % of genera and 44.2 % of species known to occur in standing waters in the province of Cuenca, were recorded during our study. Differences between León and Cuenca are mainly due to the generally poor representation of Charophytes. This can partly be explained by the fact that sampling started when short-cycle spring or winter species (e.g. *Nitella opaca*, *Tolypella* spp) had already died out. However, these species have been recorded by Alonso & Comelles (1988) in some of the lakes we studied. Both the study area and the number of sites (i.e. 82 in Cuenca and 27 in León) are considerably smaller in our study than in that by Alonso & Comelles (1988). Thus, our estimates of hydrophyte richness may be considered high.

The comparison of our recent observations with those made in 1981 shows that total genera and species richness has remained constant (Table 2). A slight decrease in the number of hygrophytes has occurred between 1981

Tabla 3. Richness of genera and species of aquatic plants of the lakes in southeast León. Richness values in León, Cuenca (Cirujano, 1995) and of lentic waters across Spain are compared. *Riqueza de géneros y especies de la flora acuática de las lagunas del sureste de León. Se realiza la comparación con la riqueza de las aguas leníticas españolas y de la provincia de Cuenca según Cirujano 1995.*

	Number of genera				Number of taxa			
	Spain	**Cuenca**	**SE León (1994)**	**SE León (1981)**	**Spain**	**Cuenca**	**SE León (1994)**	**SE León (1981)**
Charophytes	5	4	2	2	41	25	4	4
Angiosperms	28	14	11	11	89	27	19	20
Totals	34	18	13	13	130	52	23	24

and 1994 (i.e. decreasing from 87 to 78) due to the disappearance of species of genus *Carex*, which were important in Villadangos and Lagunetas in 1981.

Floristic richness in the selection of lakes and the total number of species recorded in each lake are shown in Table 4, separating hydrophytes and hygrophytes. Richness is an indicator of ecological importance and conservation. Indices estimated in 1994 and 1981 are also compared. The richest water bodies, encompassing 45% of all recorded species were Lakes Chozas de Arriba C, Sentiz, Grande, Rey and Balastrera. The poorest were Lakes Burgo Ranero, Santa Cristina, Laguna del Monte, Laguneta 2, Mayor and Estorrubio. In these lakes, an important reduction in hygrophyte species was observed between 1981 and 1994. The richest hydrophyte flora was found in the lakes exhibiting the highest overall richness. The minimum number of aquatic species per lake was

Tabla 5. Results of t-tests (dependent samples) used to compare the richness of the hydrophytic and hygrophytic flora of SE León lakes and wetlands in 1981 and 1994. *Resultados del test de la t (muestras dependientes) utilizado para comparar la riqueza de la flora hidrófila e higrófila de las lagunas en los años 1981 y 1994.*

		1981		
		Total species	**Hydrophytes**	**Hygrophytes**
1994	Total species	t = 7.182 p = 0.00000		
	Hydrophytes		t = 3.676 p = 0.00118	
	Hygrophytes			t = 6.559 p = 0.00000

		1981		
		Total species	**Hydrophytes**	**Hygrophytes**
1994	Total genera	t = 6.172 p = 0.00000		
	Hydrophytes		t = 3.815 p = 0.00082	
	Hygrophytes			t = 6.045 p = 0.00000

2. In contrast, Lakes Sentiz and Villaverde had 11 and 10 aquatic plant species, respectively. Similar results were found for genera richness because species-rich lakes were also those having greater number of genera. However, in some lakes (1, 4, 6, 12, 14, 15, 26) the number of hydrophyta genera may be small compared with the number of species because of specious genera such as *Juncus* and *Carex* (Table 4).

Overall, no apparent differences were found between the 1981 and 1984 samplings (Table 2). Important differences between dates were found, however, when values for each lake were considered separately (Table 4). In all water bodies, the number of species was greater in 1994. Hygrophyte species were those increasing most between samplings (t-test for dependent samples, for both genera and species). Significant increases in both hydrophytes and hygrophytes were apparent in 1994 (*t-texts* for dependent samples; see Table 5).

Evaluation of lakes using botanical criteria

The species of Spanish aquatic flora registered in the lakes in southeast Leon are listed in Table 6. The order of species in this list depends on the

Tabla 4. Floristic richness in each of the lakes studied. Values obtained for hydrophytes and hygrophytes are tabled separately. Results obtained in 1981 and 1994 are compared. *Riqueza florística en cada una de las lagunas estudiadas, desglosada en flora hidrófila e higrófila. Se comparan los resultados obtenidos en 1994 y 1981.*

	Hydrophytes		Hygrophytes	
	1994	**1981**	**1994**	**1981**
1 Villadangos	5	3	29	29
2 Chozas (A)	2	0	29	29
3 Chozas (B)	4	5	25	25
4 Chozas (C)	6	5	39	30
5 Laguna del Monte	3		22	
6 Rey	7	6	35	24
7 La Mayor	5	4	28	28
8 Santa Cristina	4	4	17	11
9 El Melgan	5		28	
10 Zotes del Páramo	5	5	25	20
11 Villaverde la Chiquita	10	2	29	24
12 Valdepolo	3	2	33	26
13 Laguneta 1	3	0	28	29
14 Laguneta 2	3	1	23	18
15 Sentiz	11	4	32	22
16 Mayor	4		22	
17 Del Redos	7	4	31	14
18 El Espino	4	2	31	22
19 El Estorrubio	5	6	20	15
20 La Campana	2		31	
21 El Surco	5	2	26	18
22 El Burgo Ranero	2	4	15	6
23 Bercianos Real Camino	6	5	23	19
24 Laguna Grande	6	4	37	23
25 La Balastrera	6	4	35	29
26 Villamarco	2	1	31	21
27 La Seca	4	2	27	15
Totals	23	24	78	89

value of the index I_T assigned to the aquatic flora of Spanish lakes and wetlands by Cirujano *et al*. (1992). The average index obtained for the 26 species was 3.77. A high percentage of them had an I_T value above 5. Among species with I_T values larger than 5, the most important were *Callitriche brutia, Juncus heterophyllus* and *Utricularia australis*, followed by charophytes *Chara globularis* and *Nitella translucens* and phanerogams *Hippuris vulgaris, Potamogeton gramineus, Potamogeton lucens* and *Scirpus fluitans*.

Table 7 shows the values of partial indices I_F and $I_{D'}$, and the final valuation index I_H for each lake studied. The floristic index (I_F) showed an average value of 3.25. Peak values of this index were found in Lake Villadangos (4.44) and in Lake Rey (4.04). The diversity index exceeded the value of 8 in most lakes and reached its maximum in Lakes Chozas, Rey, Sentiz, Grande and Balastrera. The average I_H across lakes was 5.78.

The definition of lakes of European, national or local interest has been accomplished considering the I_H values. Like Cirujano (1995), we considered that, from a botanical viewpoint, lakes to which an I_H value above 6.5 had been assigned, were of European importance. These lakes were Lake Rey, Lake Chozas de Arriba, Lake Sentiz and Lake Grande. Lakes of ecological interest at the level of the whole of Spain were those with I_H values between 5.5 and 6.6. These were Lakes Villadangos, Balastrera, Espino, Laguna del Monte, La Mayor, Mayor, Lagunetas, Villaverde la Chiquita and Bercianos del Real Camino.

DISCUSSION

The factor controlling aquatic plant species richness in the lakes of León is probably size of the water body (Spearman coefficient, $r_r = 0.523$, $p = 0.0051$), in conjunction with pollution and shore degradation. The richest lakes, i.e. Lakes Chozas C, Sentiz, Grande, Rey, Villaverde la Chiquita and Redos, are permanent and semipermanent and are among those with the greatest extent (Table 1). Spatial heterogeneity and related niche availability could explain the high specific richness of these systems. In this sense, Suárez *et al*. (1991) noted a significant correlation between richness and depth in small wetlands in arid and semi-arid regions. Competition could also be a major factor in determining richness levels (Holland & Jain, 1981) and high levels of competition could lead to the occurrence of a wide spectrum of growing forms of hydrophyte. We identified 11 species in Lake Sentiz, which were elodeids, myriophyllids,

Tabla 6. Evaluation of the species of aquatic flora in SE León lakes and wetlands according to the I_T index (values range from 2 to 10) proposed by Cirujano *et al* (1992). *Valoración de las especies de la flora acuática de las lagunas según el índice I_T(los valores pueden variar de 2 a 10) propuesto por Cirujano et al (1992) en la valoración de las lagunas y humedales españoles*

	I_T		I_T
Callitriche brutia	6.3	*Potamogeton crispus*	3.3
Juncus heterophyllus	6.0	*Groenlandia densa*	2.6
Utricularia australis	6.0	*Juncus bulbosus*	2.6
Chara fragifera	5.3	*Myriophyllum alterniflorum*	2.6
Hippuris vulgaris	5.3	*Polygonum amphibium*	2.6
Nitella translucens	5.3	*Potamogeton natans*	2.6
Potamogeton gramineus	5.3	*Potamogeton pusillus*	2.6
Potamogeton lucens	5.3	*Potamogeton trichoides*	2.6
Scirpus fluitans	5.3	*Ranunculus trychophyllus*	2.6
Isoetes velata	4.6	*Zannichellia palustris*	2.6
Myriophyllum verticillatum	4.0	*Chara globularis*	2.0
Callitriche stagnalis	3.3	*Lemna minor*	2.0
Ceratophyllum demersum	3.3	*Ranunculus peltatus subsp peltatus*	2.0

Tabla 7. Ecological evaluation of lakes and wetlands in the province of León on the basis of botanical criteria, following the methodology of Cirujano *et al* (1992). *Valoración de las lagunas de la provincia de León atendiendo a criterios botánicos; se realiza siguiendo la metodología de Cirujano et al (1992).*

LAKES	FLORISTIC INDEX (I_F)	DIVERSITY INDEX ($I_{D'}$)	VALUATION INDEX (I_H)
VILLADANGOS	4.44	8	6.22
CHOZAS DE ARRIBA	3.75	10	6.87
LAGUNA DEL MONTE	3.80	8	5.90
REY	4.04	10	7.02
LA MAYOR	3.68	8	5.84
STA CRISTINA	2.30	8	5.15
EL MELGAN	2.64	8	5.32
ZOTES	2.76	8	5.38
VILLAVERDE LA CHIQUITA	3.47	8	5.73
VALDEPOLO	2.95	8	5.47
LAGUNETA 1	3.53	8	5.76
LAGUNETA 2	3.53	8	5.76
SENTIZ	3.66	10	6.83
MAYOR	3.56	8	5.78
DEL REDOS	2.70	8	5.35
EL ESPINO	3.97	8	5.98
EL ESTORRUBIO	3.04	8	5.52
LA CAMPANA	3.07	8	5.53
EL SURCO	2.73	8	5.36
EL BURGO RANERO	2.95	6	4.47
BERCIANOS	3.20	8	5.60
LAGUNA GRANDE	3.40	10	6.70
LA BALASTRERA	2.36	10	6.18
VILLAMARCO	2.60	8	5.30
LA SECA	3.02	8	5.51

batrachiids, nymphaeids, ceratophyllids and charids. Lakes Villadangos, Bercianos, Zotes, Melgán and Burgo Ranero, which are large lakes and/or permanent lakes, were comparatively poorer than the abovementioned lakes because of filling in of their basins or because of their location near villages and human-induced strong alteration of shore areas (Fernández Aláez, 1986).

It is not surprising that the overall composition of macrophytic flora, evaluated as the total richness of genera and species, has remained constant since 1981, as local extinctions of species in temporary lakes are thought to be rare, despite considerable interannual variations in habitat availability (Zedler, 1981). Thus, fluctuations in richness of each lake did not seem to affect total richness for the whole area studied. Small plant size, abundant seeds per unit biomass and high vegetative and reproductive plasticity, lessen the probability of extinction, too (Williams, 1987). Low richness values in many lakes in 1981 as compared with 1994, could be explained by severe drought occurring before and during the 1981 sampling (Fernández Aláez, 1984). A number of tolerant species, which were widely distributed in wetter years, were practically eliminated in 1981.

In semi-arid regions like León, wetland communities are flexible. Once their structure has been altered, they are able to suit the new situation and recover quickly (Begon, *et al*., 1988). Recovery of annual communities is dependent on the germination of seeds during the recharge phase. When the desiccation period extends for

too long, as was the case of the León region, recovery will depend on the viability of the seeds in the sediments. Seed viability diminishes with time if no new flood rejuvenates the seed bank. Consequently, the species richness in the 1981 sampling could have well been affected by intense drought. In contrast, heavy rains in winter and spring 1994 gave rise to the appearance of a high number of annual species. This suggests that the seed bank in the lakes studied is in good condition, allowing rapid recolonization of the lakes by plant species with seeds in the sediment.

The species of aquatic plant of the lakes in southeast León have different patterns of distribution. *Myriophyllum alterniflorum* or *Polygonum amphibium*, for instance, are widely represented, while other species are more local, such as *Potamogeton lucens, Myriophyllum verticillatum, Chara fragifera, Lemna minor, Potamogeton pusillus, Zannichellia palustris* and *Callitiriche stagnalis*. It is evident that the assessment of their present importance calls for the revision of their significance within States and at the European scale. Criteria and indices proposed by Cirujano *et al*. (1992) and Cirujano (1995) have been regarded as a useful reference. *Callitriche brutia, Juncus heterophyllus* and *Utricularia australis* are important species given their scarcity in both Spain and in the whole of Europe. These species are present in several of the lakes studied in León and though they cannot be referred to as rare, their occurrence seems to be clearly on the decline. *Utricularia australis* is characterized by being present in dystrophic environments (i.e. Lakes Rey, Villadangos, Chozas de Arriba and Sentiz), which are described as endangered in Europe. In Lake Rey this species was abundant in 1981 (Fernández Aláez, 1984). The late sampling indicates an important loss of biomass of this species, suggesting its regression in the area.

The presence of *Hippuris vulgaris*, *Chara fragifera*, *Scirpus fluitans* and *Ceratophyllum demersum*, rare species in Spain, but recorded locally in 1 or 2 sites, was evaluated. In Lake Grande, *Hippuris vulgaris* was very abundant in well-kept communities, together with *Scirpus lacustris* and *Potamogeton lucens*. This species is considered of outstanding interest within the national context by Cirujano (1995), who recommends the protection of wetlands wherever it is found.

The following species ocurring in the lakes of León are scarce nationwide*: Nitella translucens, Potamogeton lucens, Potamogeton gramineus*, *Myriophyllum verticillatum* and *Ceratophyllum demersum*. In permanent lakes, *Nitella translucens* was found in Lakes Chozas B, Sentiz, Rey and Villaverde la Chiquita; *Potamogeton lucens* in Lake Grande; *Potamogeton gramineus* in Lakes Rey, Sentiz and Villaverde la Chiquita and *Ceratophyllum demersum* in Lakes Sentiz and Zotes. Cirujano (1995) attributes an outstanding interest to *Ceratophyllum demersum* and *Potamogeton lucens* because their distribution has decreased alarmingly in recent years. In León, compared to the 1981 sampling, these species do not seem to be on the decline. Their scarcity in the province, however, advises their protection.

The richness of hygrophyte species has also been regarded as a criterion for the conservation of wetlands. In many of the small lakes studied, their temporary character leads to the development of an abundant marginal vegetation. Comparisons have been made between wetlands in León and in other parts of Spain, following the methodology proposed by Cirujano et al. (1992). The average value of the I_H index for lakes in León (I_H=5.78) is well above that obtained for the whole of Spanish wetlands (I_H=4.05) and also larger than the I_H obtained for lakes in the province of Cuenca (I_H=4.48). Differences between León and the rest of Spain are due to the high diversity index (I_D) for León, since the mean value of the floristic index is very similar in León and in other Spanish wetlands (mean of 3.27 in Spanish wetlands). Values assigned to this community by the Cirujano index (Cirujano *et al*., 1992) can give an overestimation of conservation value for some wetlands**.** This, however, does not seemed to have happened when comparing ecological value of lakes in León and in Cuenca, since exhaustive surveys of the hygrophytic flora

have been carried out in both areas. The I_D index must be previously adapted for each study, depending on the intensity of sampling of the marginal zone.

Lake Chozas de Arriba is considered to be important nationwide (Cirujano *et al*., 1992). In our study, this lake is also considered of European interest from estimates of species richness. In addition, using avifaunal criteria, this lake has also been considered of international importance, because of its nesting population of lapwings (Fernández Aláez, 1996).

Analogously, Cirujano *et al*. (1992) attached international importance to the lakes of Burgo Ranero, using records available in the literature. Lakes were included in this designation on the basis of geographical proximity and ecological similarity, e.g. Lakes Estorrubio, Espino, Redos and Burgo Ranero. However, Lake Grande and wetlands of the Páramo Leonés were erroneously included with the former, despite their location being distant from the first group. The result is an overestimate of ecological importance of those lakes which, considered singly, can "only" be of national interest (e.g. Lake Espino). In contrast, our results show Lake Grande alone deserves the designation of site of European interest.

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