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# Proposal of a rapid methodology to assess the conservation status of Mediterranean wetlands and its application in Catalunya (NE Iberian Peninsula)

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## Abstract

*The implementation of the Water Framework Directive (2000/60/EC) requires the development of bioassessment methods for ecological quality of wetlands and other shallow lentic ecosystems. Several proposals have been developed for the assessment of water quality and the trophic status of these and other ecosystems. However, water quality assessment does not show the conservation status of the whole ecosystem. Human activities have changed wetland morphology, size and ecological processes, although these alterations do not always affect water quality. We propose an index (ECELS index) which has been used to evaluate the conservation status of shallow lentic ecosystems of Catalunya (NE Iberian Peninsula). The ECELS index, a rapid bioassessment method, is based on five components: (1) basin littoral morphology, (2) human activity, (3) water characteristics, (4) emergent vegetation, and (5) hydrophytic vegetation. In Catalunya, 42% of the wetlands had a good or a high conservation status. Here we show that, among wetland types, the thalassohaline and temporary freshwater wetlands displayed the best conservation status. No significant differences were found among ECELS scores and land use types or population densities. In contrast, significant differences in ECELS scores were found between managed and non-managed wetlands (protected or not).*

**Keywords:** *rapid bioassessment, conservation status, shallow waters, Mediterranean wetlands*

## Résumé

**Proposition d'une méthode rapide pour l'évaluation du statut de conservation de zones humides méditerranéennes et son application en Catalogne (NE Péninsule Ibérique)**

*La mise en application de la directive cadre sur l'eau (2000/60/EC) exige le développement de méthodes d'évaluation biologique pour le suivi de la qualité écologique des zones humides et d'autres écosystèmes lentiques peu profonds. Plusieurs propositions ont été élaborées pour évaluer la qualité de l'eau ainsi que l'état trophique des écosystèmes aquatiques. Cependant, l'évaluation de la qualité de l'eau n'indique pas le statut de conservation de l'écosystème entier. Les activités humaines ont modifié la morphologie et la taille des zones humides et les processus écologiques qui s'y déroulent, même si elles n'affectent pas toujours la qualité de l'eau. Nous proposons un index (ECELS index) qui a été utilisé pour évaluer le statut de conservation des écosystèmes lentiques peu profonds de la Catalogne (NE de la Péninsule Ibérique). L'index ECELS est une méthode de rapid bioassessment qui est basée sur cinq composantes: (1) la morphologie du littoral du bassin, (2) l'activité humaine, (3) les caractéristiques de l'eau, (4) la végétation émergeante et (5) les hydrophytes. En Catalogne, 42% des zones humides montrent un bon ou très bon statut de conservation. Les statut les meilleurs sont observés pour zones humides saumâtres ou temporaires d'eau douce. Il n'y a pas de différences significatives entre les scores ECELS des différents types d'utilisation du sol ou des différentes densités de population. Des différences significatives ont par contre été trouvées entre les scores ECELS des zones humides gérées et non-gérées (qu'elles soient protégées ou non).*

**Mots-clés:** *évaluation rapide, statut de conservation, eaux peu profondes, zones humides méditerranéennes*

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## Introduction

The degradation of continental aquatic ecosystems during the last decades is well known. The primary causes are believed to be pollution caused by point or diffuse seepage of fertilizers and contaminants, excessive exploitation of water resources, human alteration of water flows, and utilization of wetland lands for other uses (Mitsch and Gosselink 1993; Gopal and Junk 2000). The present ecological status of the aquatic ecosystems has led the European Union to develop the Water Framework Directive (European Directive 2000/60/EC), where the community action framework on water policies has been established. The main objective of this directive is to promote the rational use of water resources and the conservation, protection and improvement of the quality of European aquatic ecosystems.

In recent years, the use of indicators for the evaluation of ecological quality of aquatic ecosystems has been widely discussed and validated (Loeb and Spacie 1994; Davis and Simon 1995; Wright et al. 2000; Rosenberg and Resh 2001). Biological indicators for the evaluation of water quality have been studied, particularly in fluvial and lacustrine ecosystems (e.g. Gannon and Stemberger 1978; Ghetti and Ravera 1994; Furse et al. 1987; Matveeva 1991; Sabater et al. 1996; Verneaux et al. 2004), but to a lesser degree in wetlands (Burton et al. 1999; Simon et al. 2000; Pennings et al. 2002; Lougheed and Chow-Fraser 2002).

However, water quality is no indicator of the artificiality and the loss of natural values experienced by some wetlands. For example, some wetlands with high water quality have nevertheless been degraded in their morphology, or have been subjected to intense urbanization in the form of buildings, roads, etc. Even artificial ponds made for irrigation purposes may contain high water quality, although their natural value is usually low. In contrast, some natural and valuable ecosystems are being stressed by agricultural or livestock contaminations, resulting in poor water quality. This double perception of the environmental quality of lentic ecosystems means that a separate evaluation of water quality and conservation status needs to be taken into consideration.

Wetland indices are being developed mainly to evaluate water quality (e.g. Lougheed and Chow-Fraser 2002; Boix et al. in press). There exist some European approaches that include characteristics that can be used to assess several aspects of wetland conservation status (Moss et al. 2003), but up till now, the conservation status of wetlands has been neglected. However, arrays of methodologies are being developed in several countries for measuring wetland conservation (e.g. Mack 2001; Butcher 2003; Fennessy et al. 2004).

The aim of this study is to describe a rapid bioassessment method, designed to assess the conservation status of Mediterranean wetlands. Evaluation of its applicability was carried out in a wide territorial wetland study in Catalunya. The acronym *ECELS* refers to the Catalan "Estat de Conservació d'Ecosistemes Lenítics Soms" (Shallow Lentic Ecosystem Conservation Status).

## Methods

### *Criteria to establish reference conditions for conservation status*

We described the conservation status as the degree of natural attributes that a wetland maintains in spite of human activity. However, natural attributes are often difficult to establish, especially in territories that have been under human pressure for long time, and hence natural or reference sites are practically impossible to find (Moss et al. 2003). An alternative approach is to define theoretical attributes that a well-preserved wetland would be expected to have. The attributes considered in this proposal were based on several revisions of widely used attributes in conservation assessments (Furniss and Lane 1992; Britton and Crivelli 1993; Curcó 1996; Bartoldus et al. 1999; Williams et al. 1999; European Union 2003; Fennessy et al. 2004), together with additional criteria that were derived from an exhaustive survey conducted by the authors. According to these criteria, wetlands with high conservation status would present smooth littoral slopes that allow a wide area of inundation, negligible effects of human uses, and non-altered water quality and biotic communities. In order to have an efficient rapid assessment (maximum two people working half a day in the field; Fennessy et al. 2004), the vegetation structure was used to estimate the alteration of the natural biotic communities, because its assessment is less time-consuming than that of other community fractions. It should be noted that a relationship between vegetation structure and invertebrate richness has been previously reported (Quade 1969; García-Criado et al. 2005). Similarly, the water attributes proposed here are those that do not require laboratory chemical analyses. Note that this rapid assessment proposal does not aim to estimate the water quality of Mediterranean wetlands, since a biotic index based on limnological variables and faunal assemblages has simultaneously been developed for this purpose (Boix et al. in press).

### *Basis of the ECELS index and preliminary considerations*

The *ECELS* index follows the rationale of the RCE index (Petersen 1992) and the QBR index (Munné et al. 2003) both of which were developed for lotic environments. In order to evaluate the conservation status of wetlands, morphological and hydrological characteristics, land uses (in or around the basin), and vegetation status aspects have been considered. The index is composed of 5 components, each assessing an independent aspect of the conservation status of a wetland. Each component is composed by one or several sections with excluding options, which give scores to the component (only one answer per section can be chosen). Also, each component has a modifying section that assesses additional particularities of the component where one or several options can be chosen resulting in addition or subtraction of points. The score obtained for each component cannot exceed a maximum value nor have negatives values. The maximum values of the 5 components are 20, 20, 10, 30 and 20, respectively (see Appendix). The sum of all the values obtained for each component gives the *ECELS* index final score, which can range between 0 and 100.

In order to have a global assessment of the conservation status of the wetland, its size must be taken into account. Calculation of the *ECELS* index needs to be done on one to three different sites of the wetland, depending on this size i.e. wetlands less than 0.5, 0.5-5 and larger than 5 hectares are recommended to have 1, 2 or 3 sites respectively. The sites chosen must be randomly selected and as equitably distributed as possible. In the case of two or more sites, the *ECELS* index final score should be the median of the scores obtained at each site.

Surveys wishing to obtain the *ECELS* index should be performed in spring (better in May or June), as this is the best time to assess many of the aspects considered in the index, since during this period the vegetation of the wetlands is well developed. Also, periods of flooding or drying, which can occur in winter or early spring, or in summer, respectively, should be avoided. Even if the *ECELS* index is calculated during late spring flooding (when several basins are connected) or drying (when the water is far from the littoral of the basin) situations should be avoided. In those cases in which several basins are connected during flooding periods, but are isolated during summer, the assessment must be done for individual basins, instead of calculating the *ECELS* index on all the basins together

### Description of the ECELS index components

*Basin littoral morphology.* This component assesses the slope of the littoral zone of the wetland. The littoral is the perimeter of a basin when the water reaches its highest level (if the water is at its highest level and comprises several basins, a different evaluation for each basin must be done, with the exception of flooding conditions). Smooth slopes in the littoral zone indicate a potential expansion of flooded areas during flooding periods, which may be frequently limited in altered wetlands. Furthermore, smooth slopes allow the existence of different habitats that may increase the overall biodiversity of the wetland (Biggs et al. 1994; Williams et al. 1999). The anthropogenic effects on the wetland are not only assessed by alteration of littoral morphology but also by the presence of structures or activities that affect the volume of water in the wetland (construction of levees or burial of the basin).

*Human activity.* This component is related to the human activity around or inside the basin, and assesses the impact of this activity on the functioning of the wetland and its neighbouring catchments. Several aspects are considered, such as hydraulic equipments, transport and building facilities, or agricultural and livestock activities. The frequency of people visiting the wetland, the presence of rubbish or exotic fauna, and the existence of management or protection activities, serve to modify the features of this component. To assess the presence of exotic fauna, it is not necessary to perform a thorough survey of the system, but only evaluate their presence while calculating the index. An overlooked exotic taxon will not affect the overall score of the index.

*Water characteristics.* It is not the intention of this index to assess water quality directly, but only some of its characteristics, such as transparency or odour, because they can reflect intense anthropogenic effects. The aim is to evaluate non-natural turbidity and not to lessen the index score of natural one (e.g., claypans). The odour of hydrogen sulphide will not be taken into account when the sediment is disturbed.

*Emergent vegetation.* The aim of this component is to evaluate how far the wetland is from the natural composition and the zonation of the vegetation belt (Chapman 1974; Folch 1986; Grillas et al. 2004). A semi-quantitative abundance approach is proposed, although it is modified by a rough evaluation of the composition of the helophytic or halophytic vegetation. The abundance approach takes into account the extension of the vegetation on the perimeter of the wetland and the extension of the vegetation inside the basin. The score obtained by the abundance estimation is modified by the dominant species of the community, the presence of exotic plants, and the presence or absence of trees around the wetland. While this component of the index assesses mainly the vegetation of permanent and semi-permanent wetlands, positive scores are given to temporary and very shallow permanent wetlands (< 30 cm). This is because these habitats will not display the same aspects of the vegetation as in the semi- and permanent and would therefore get lower scores.

*Hydrophytic vegetation.* For this component, a very similar approach of semiquantitative abundance and rough composition evaluation is proposed for submersed and floating vegetation. In this case, a rough cover estimation is assessed for both submersed and

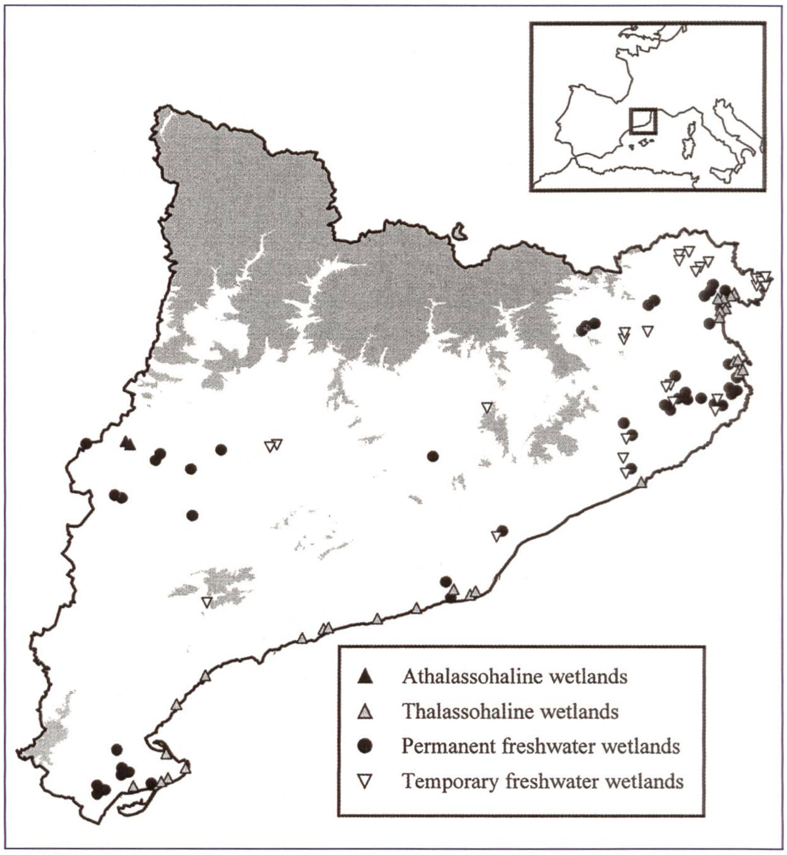


*Fig. 1: Map of Catalunya, showing the wetlands analysed. The wetlands are coded according to their types. The shaded part of the map represents the area above 800 m a.s.l.*

floating vegetation, and the score modified by the dominant plant group in the community, together with the presence of exotic species. After obtaining the final numerical score of the *ECELS* index, a categorization of the values is proposed (Table 1) following the guidelines of the Water Framework Directive (2000/60/EC).

## Study Area

The *ECELS* index has been applied to 106 wetlands in Catalunya (NE Iberian Peninsula), comprising ponds, lagoons and marshes (Fig. 1). All the wetlands have in common that they are less than 6 m deep and are situated below 800 m a.s.l. Both criteria were proposed to ensure that all the waterbodies have the ecological characteristics of shallow Mediterranean wetlands. Another characteristic of the studied wetlands is that the majority (> 80%) are smaller than 5 hectares. For more information on physical, chemical and biological characteristics of the wetlands, see Table 2.

*Table 1: Categories of conservation status for the numerical values of the ECELS index, following the Water Framework Directive (2000/60/EC).*

| Conservation status class | | *ECELS* index score |
|---|---|---|
| I | High | ≥ 90 |
| II | Good | 70 – 89 |
| III | Moderate | 50 – 69 |
| IV | Poor | 30 – 49 |
| V | Bad | < 30 |

*Table 2: Physical, chemical and biological characteristics of the 106 wetlands for each wetland type and for all the wetlands altogether, showing mean, in bold, and standard deviation. Size class 1 corresponds to wetlands smaller than 0.5 ha, size class 2 to wetlands between 0.5 and 5 ha, and size class 3 to wetlands bigger than 5 ha. Abbreviations: Cond: conductivity; D.O.: dissolved oxygen; Chl-a: chlorophyll-a; TP: total phosphorus; SRP: soluble reactive phosphate; TN: total nitrogen; Amm: ammonium; ATW: Athalassohaline wetlands; THW: Thalassohaline wetlands; FPW: Freshwater permanent wetlands; FTW: Freshwater temporary wetlands.*

| Types | Size class 1 | 2 | 3 | Cond. ($mS \cdot cm^{-1}$) | pH | D.O. (%) | Chl-a ($\mu g \cdot L^{-1}$) | TP ($\mu g \cdot L^{-1}$) | SRP ($\mu g \cdot L^{-1}$) | TN ($\mu g \cdot L^{-1}$) | Amm. ($\mu g \cdot L^{-1}$) | Nitrite ($\mu g \cdot L^{-1}$) | Nitrate ($\mu g \cdot L^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATW | 2 | - | - | **37.2** | **8.1** | **79.0** | **8.7** | **561.8** | **2.0** | **8255.4** | **108.0** | **39.0** | **3096.4** |
| | | | | 31.9 | 0.3 | 18.5 | 6.3 | 434.7 | 2.7 | 5623.6 | 179.4 | 56.8 | 4485.8 |
| THW | 8 | 10 | 10 | **20.3** | **8.2** | **86.9** | **16.8** | **495.4** | **51.0** | **1837.9** | **145.8** | **10.0** | **339.6** |
| | | | | 16.0 | 0.5 | 46.6 | 17.0 | 2449.4 | 79.1 | 1503.5 | 267.3 | 15.9 | 841.9 |
| FPW | 16 | 26 | 6 | **1.9** | **7.8** | **67.7** | **24.0** | **1818.4** | **159.9** | **4245.9** | **634.1** | **31.9** | **1751.0** |
| | | | | 4.2 | 0.6 | 35.9 | 59.9 | 8136.6 | 408.6 | 6180.2 | 2695.2 | 79.8 | 3171.5 |
| FTW | 19 | 8 | 1 | **0.8** | **7.6** | **77.9** | **10.1** | **760.1** | **105.4** | **2538.8** | **163.3** | **14.9** | **920.5** |
| | | | | 0.8 | 0.6 | 34.4 | 19.8 | 2118.4 | 393.9 | 4578.1 | 465.6 | 59.3 | 4300.0 |
| Total | 45 | 44 | 17 | **10.4** | **7.9** | **78.0** | **18.0** | **1034.3** | **99.4** | **2987.9** | **329.5** | **19.6** | **1019.7** |
| | | | | 15.3 | 0.6 | 41.1 | 39.4 | 5309.1 | 304.8 | 4581.9 | 1670.4 | 56.7 | 2830.6 |

### Relation of the conservation status to wetland types and socio-economical parameters

In order to fulfil the guidelines of the Water Framework Directive the wetlands of Catalunya were classified by using the aquatic invertebrate community from a previous study on water quality assessment methods (Boix et al. in press). Thus, four wetland types were described in Catalunya, which can be separated according to water salinity and temporality: athalassohaline, thalassohaline, freshwater permanent and freshwater temporary wetlands.

To assess the relation between *ECELS* index scores and rough socio-economical characteristics of the region, three parameters were chosen: land use, environmental protection and population density. The land use database was composed of 8 categories (Gracia et al. 2003). The categories of land use selected for this study were the first two that attained the criteria of being more than 25% of the total municipal area, except for the category of artificial unproductive areas, which had to meet the criteria of being more than 10% to be selected. Thus, the resulting six categories were: forest, cultivation, artificial unproductive area, forest and cultivation, forest and artificial unproductive areas, and cultivation and artificial unproductive areas. The environmental protection indicates if the wetland is situated in a managed protected area, in a protected area without management, or in an unprotected area. Managed protected areas are natural parks, which develop strategies for conservation of the protected area. In contrast, protected areas without management do not have any specific institution to carry out conservation strategies. The population density was obtained from Institut d'Estadística de Catalunya (2003), giving rise to 3 categories: municipal population less than or equal to 50 inhabitants · km$^{-2}$, between 50 and 500 inhabitants·km$^{-2}$, and more than 500 inhabitants·km$^{-2}$.

Differences in *ECELS* index scores for each type and socio-economical parameters were explored. ANOVA tests were carried out when the assumptions of normality and homogeneity of variance were confirmed, and a Kruskall-Wallis test when they were not confirmed. Post-hoc tests (Tukey's HSD) were performed when necessary, in order to identify the significantly different groups. The relation among components of the *ECELS* index were analysed using Spearman's rank correlation. All statistical analyses were carried out using the statistical package SPSS 11.5.1 for Windows.

*Table 3: Percentage of wetlands in each conservation status category for each wetland type, and for all the wetlands together. Abbreviations: ATW: Athalassohaline wetlands; THW: Thalassohaline wetlands; FPW: Freshwater permanent wetlands; FTW: Freshwater temporary wetlands.*

| Wetland types | n | Conservation status categories I | II | III | IV | V |
|---|---|---|---|---|---|---|
| ATW | 2 | 50.0 | 50.0 | 0.0 | 0.0 | 0.0 |
| THW | 28 | 14.3 | 46.4 | 21.4 | 17.9 | 0.0 |
| FPW | 48 | 4.2 | 14.6 | 45.8 | 31.3 | 4.2 |
| FTW | 28 | 17.9 | 39.3 | 28.6 | 14.3 | 0.0 |
| Total | 106 | 11.3 | 30.2 | 34.0 | 22.6 | 1.9 |

## Results

Considering all the wetlands of Catalunya, 41.5% were of a good or a high conservation status, while 34.0% of a moderate status, and 24.5% of a poor or a bad status (Table 3). The very good results of conservation status obtained for athalassohaline wetlands cannot be considered as representative for Catalunya, since they are rare and therefore they were not taken into account in subsequent analyses. Thalassohaline and temporary freshwater wetlands were the best preserved, each having more than 57% of their wetlands in the categories of high or good conservation status. Both these types did not have any wetland in the category of bad conservation status. The permanent freshwater wetlands got worse results than the other types, having 45.8% of the wetlands in a moderate conservation status, and being the only habitat with representatives in a bad conservation status.

In three cases, significant correlations were found between the five components of the *ECELS* index (Table 4). The relatively low correlation coefficient ($r_s < 0.35$), indicates a weak association between the components.

Changes in the component values among each conservation status category were different in relation to the component under consideration (Table 5). For example, the changes in component 3 values were not observed until the last conservation status category, while changes in components 2 and 5 values were gradual from the second conservation status category onwards. Component 1 followed the same pattern, except for the freshwater temporary wetlands, where it was more conservative. In compo-

*Table 4: Correlation coefficients between ECELS index component scores (n = 106). Abbreviations: n.s.: not significant. * p < 0.05; ** p < 0.01.*

| | Component 1 | Component 2 | Component 3 | Component 4 |
|---|---|---|---|---|
| Component 2 | 0.34** | | | |
| Component 3 | n.s. | n.s. | | |
| Component 4 | n.s. | n.s. | n.s. | |
| Component 5 | n.s. | 0.21* | 0.21* | n.s. |

nent 4, the changes were only important when the wetland had a bad conservation status (only observable in freshwater permanent wetlands).

There were no significant differences between *ECELS* index scores and land use or population density (Fig. 2). In spite of no significant differences, the low values and the low variability of *ECELS* index scores in the land use categories which contained artificial unproductive areas, is remarkable (except for the category of cultivation and artificial unproductive areas, where close to 50% of the wetlands in this category are in a natural park). In contrast, a significant difference was found between the *ECELS* index score and environmental protection ($F_{2,101}$ = 5.344; $p$ = 0.006). Significant differences in *ECELS* index scores were found between managed protected areas and non-managed (protected or not) ones (Tukey's HSD; $p < 0.05$).

Significant differences were found for *ECELS* index scores among different wetland types ($F_{2,101}$ = 10.976; $p < 0.0005$). Freshwater permanent wetlands were significantly different from the thalassohaline and freshwater temporary wetlands (Tukey's HSD; $p < 0.05$).

## Discussion

### *ECELS index and the Water Framework Directive*

According to the European Water Framework Directive, the classification of ecological status must be done by means of water quality, including biological and physicochemical elements, but also by means of hydromorphological aspects. The *ECELS* index was developed as a measure of conservation status of wetlands, that includes elements for evaluating physicochemical, hydromorphological and biological characteristics, and assessment of anthropogenic degradation of those elements. Although few studies have been carried out to assess the conservation of hydromorphological characteristics of wetlands (Mack 2001), less efforts have been made to include them within a global evaluation of the wetland's ecological status (Moss et al. 2003). The *ECELS* index has been created as an independent tool that can be used (with appropriate adaptations) together with other water quality assessment indices to establish the ecological status of wetlands. Similarly, in Catalunya, the *ECELS* index was developed in conjunction with a biotic index, which evaluates the water quality based on the composition and the structure of crustacean and insect assemblages (*QAELS* index; Boix et al. in press). Therefore, to obtain the ecological status of Catalan wetlands, we propose the usage of both indices.

*Table 5: Mean values of ECELS components for conservation status categories and for wetland types. Abbreviations: ATW: Athalassohaline wetlands; THW: Thalassohaline wetlands; FPW: Freshwater permanent wetlands; FTW: Freshwater temporary wetlands.*

| Wetland types | Conservation status category | Component 1 | Component 2 | Component 3 | Component 4 | Component 5 |
|---|---|---|---|---|---|---|
| ATW | I | 20 | 19 | 10 | 30 | 20 |
| | II | 20 | 19 | 10 | 20 | 20 |
| | III | - | - | - | - | - |
| | IV | - | - | - | - | - |
| | V | - | - | - | - | - |
| | All together | 20 | 19 | 10 | 25 | 20 |
| THW | I | 20 | 18 | 10 | 30 | 19 |
| | II | 15 | 13 | 10 | 29 | 13 |
| | III | 13 | 7 | 8 | 29 | 6 |
| | IV | 5 | 5 | 10 | 17 | 5 |
| | V | - | - | - | - | - |
| | All together | 14 | 11 | 10 | 27 | 11 |
| FPW | I | 20 | 20 | 10 | 30 | 20 |
| | II | 13 | 15 | 10 | 25 | 12 |
| | III | 7 | 9 | 9 | 27 | 6 |
| | IV | 5 | 4 | 9 | 20 | 3 |
| | V | 0 | 10 | 9 | 3 | 8 |
| | All together | 8 | 9 | 9 | 24 | 7 |
| FTW | I | 20 | 17 | 10 | 30 | 17 |
| | II | 20 | 14 | 10 | 28 | 7 |
| | III | 18 | 6 | 9 | 24 | 2 |
| | IV | 15 | 7 | 7 | 16 | 0 |
| | V | - | - | - | - | - |
| | All together | 19 | 11 | 9 | 25 | 6 |

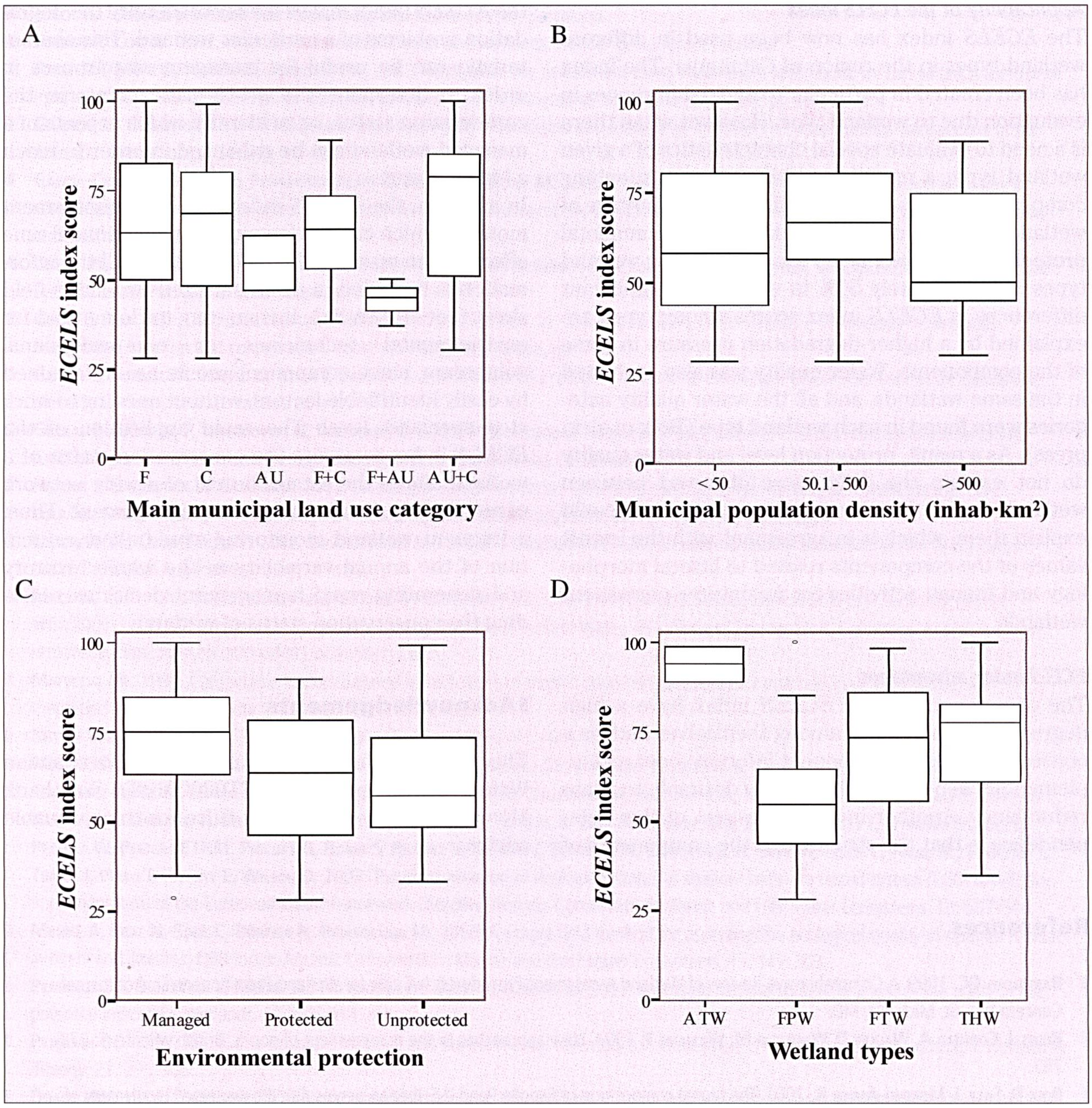


*Fig. 2: Box-plot graphics for ECELS index scores vs. land use category (A), population density (B), environmental protection (C) and wetland types (D). Abbreviations: F: Forested; C: Cultivation; AU: Artificial Unproductive Areas; ATW: Athalassohaline wetlands; THW: Thalassohaline wetlands; FPW: Freshwater Permanent Wetlands; FTW: Freshwater Temporary Wetlands.*

### ECELS in relation to types and socio-economic parameters

Although there are wetlands in Catalunya with a high and good conservation status, there are still many with lower conservation status (moderate to bad). The lower conservation status of these wetlands is due to different kinds of pressure, which varies among wetland types, but is mainly related to morphology of the basins, human activities in or around them, and hydrophytic vegetation. The thalassohaline wetlands receive great pressure from human activities related to tourism, transport facilities and over-visiting. In freshwater permanent wetlands, another degradation aspect can be added, which involves a modification of the littoral mainly from transformations of the wetlands in water reservoirs. In contrast, freshwater temporary wetlands have, in general, the best conservation of the littoral morphology, and they are mainly affected by human activities and degradation of hydrophytic vegetation. The degradation pressure differs according to the wetland type. Large numbers of temporary freshwater and thalassohaline wetlands have disappeared in Catalunya because of agricultural and touristic pressure, respectively (Boix et al. 2001, Quintana et al. 2002), and therefore those remaining nowadays are the ones that are not much affected by human activity.

### *Applicability of the ECELS index*

The *ECELS* index has now been used in different wetland types in the region of Catalunya. The index has been created in particular to avoid differences in evaluation due to wetland type. However when there is a need to evaluate special characteristics of a given wetland type, a modifier within the corresponding component adjusts the score. Since the percentage of wetlands that are under some kind of environmental protection is approximately the same among wetland types (approximately 50% in each one), significant differences in *ECELS* index scores among types are explained by a higher degradation pressure in some of the components. Water quality was also evaluated in the same wetlands, and all the water quality categories were found in each wetland type (Boix et al. in press). As a result, protection level and water quality do not explain the differences observed between wetland types. However human activities could explain them, which is in agreement with the lowest values of the components related to littoral morphology and human activities for freshwater permanent wetlands.

### *ECELS index advantages*

The components of the *ECELS* index have a high degree of independence among themselves and, as a consequence, each component informs about a complementary aspect, which is highly desirable to abate redundancy. Another important aspect of this independence is that the structure of the components of the *ECELS* index makes it easy to identify the degradation problems of a particular wetland. This characteristic can be useful for management purposes in order to determine the problematic points in the conservation status, or to identify which aspects of a managed wetland can be enhanced in order to reach a higher status.

In addition, the *ECELS* index is a rapid assessment method, which can be done in situ with minimal time effort (often no more than 10 minutes). All the information is recorded in a standardized two-sided field sheet (see Appendix). It is an easy-to-do method for environmental technicians or non-professional volunteers, since component scores are determined by easily identifiable factors, without needing to work at a specialist level. The rapid application of the *ECELS* index to assess the conservation status of a wetland allows the establishment of a wide network of monitoring sites for long-term management. Thus, a frequent wetland monitoring would allow estimation of the annual variability in the whole territory and generating rapid management decisions regarding the conservation status of wetlands.

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**Appendix: Shallow Lentic Ecosystems Conservation Status (ECELS) field sheet.**

WETLAND: DATE:
LOCALITY: GRAND TOTAL: ☐
UTM (x,y):

**COMPONENT 1. Morphology** **Maximum – 20 points**

1.1. Littoral slope

| | |
|---|---|
| a) Prevailing slope of less than 25% | 20 |
| b) Prevailing slope between 25 and 50% | 10 |
| c) Prevailing slope between 50 and 75% | 5 |
| d) Prevailing slope of more than 75% (absence of littoral) | 0 |

<u>*Component 1 modifiers*</u>

| | |
|---|---|
| *A. Presence of weirs, levees or embankments on more than 50% of the perimeter of the wetland* | |
| *a) Made from soil* | *-5* |
| *b) Made from concrete, plastic or rocks* | *-10* |
| *B. Evidences of burial of the wetland* | *-10* |
| *C. The bottom of the wetland is covered with an impermeable liner* | *-15* |

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**COMPONENT 2. Human activity** **Maximum – 20 points**

| | |
|---|---|
| 2.1. Hydraulic infrastructures related to water uses of the wetland (e.g. water extraction, channels, etc. Do not take in consideration weirs or dams) | |
| a) Absence | 5 |
| b) Presence | 0 |
| 2.2. Transport infrastructures at less than 100 m. | |
| a) Absence | 5 |
| b) Unpaved road | 3 |
| c) Paved road, street or railway | 0 |
| 2.3. Buildings at less than 100 m (choose the more restrictive option, in the case of more than one option) | |
| a) Presence of campsites, wastewater treatment plants, farms, industrial plants, etc. | 0 |
| b) Presence of golf course facilities | 2 |
| c) Presence of buildings. To be determined according to the wetland surface: | |

| | < 0.5 ha | 0.5 – 5 ha | > 5 ha |
|---|---|---|---|
| a) Absence | 5 | 5 | 5 |
| b) From 1 to 10 buildings | 0 | 1 | 3 |
| c) More than 10 buildings | 0 | 0 | 0 |

| | |
|---|---|
| 2.4. Agricultural uses, livestock or plantations | |
| a) Absence | 5 |
| b) Presence of agricultural uses, livestock or plantations around the wetland | 3 |
| c) Agricultural uses, livestock or plantations affecting the littoral of the wetland | 1 |
| d) Agricultural uses, livestock or plantations inside the wetland | 0 |

<u>*Component 2 modifiers*</u>

| | |
|---|---|
| *A. Frequency of visits to the wetland:* | |
| *a) Medium frequency (groups of people visiting the wetland at least once a week)* | *-3* |
| *b) High frequency (almost always people visiting the wetland)* | *-5* |
| *B. Conservation* | |
| *a) Significant presence of visible rubbish on water* | *-5* |
| *b) Significant presence of visible rubbish around the wetland* | *-3* |
| *c) Environmental information and management (only choose an option)* | |
| *c.1) Informative panels, hides or lookouts* | *+1* |
| *c.2) Protected area* | *+3* |
| *c.3) Managed wetland* | *+5* |
| *C. Presence of allochthonous or domestic fauna* | *-5* |

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| COMPONENT 3. Water aspects | Maximum – 10 points |
|---|---|
| 3.1. Transparency | |
| a) Transparent water (< 5 NTU) | 5 |
| b) Low turbidity (5 - 15 NTU) | 2 |
| c) High turbidity (> 15 NTU) | 0 |
| 3.2. Odour | |
| a) Strong odour is detected | 0 |
| b) Strong odour is not detected | 5 |
| *Component 3 modifiers* | |
| *a) Turbidity of natural origin (e.g. claypans)* | *+5* |

| COMPONENT 4. Emergent vegetation | Maximum – 30 points |
|---|---|
| 4.1. Cover of wetland perimeter | |
| a) Absence | 0 |
| b) Presence (<25%) | 5 |
| c) Between 25 and 90% | 10 |
| d) Complete belt (>90%) | 15 |
| 4.2. Inside wetland | |
| a) The whole wetland is occupied (>90%) | 0 |
| b) Occupied between 50 and 90% | 5 |
| c) Occupied between 25 and 50% | 10 |
| d) Only the wetland shore | 15 |
| e) Absence | 0 |
| *Component 4 modifiers* | |
| *A. Dominant community* | |
| *a) Giant reed community (dominance giant reed > 50%)* | *-10* |
| *b) Common reed community (dominance common reed > 95%)* | *-5* |
| *c) Multispecific community or community dominated by another species* | *+10* |
| *d) Significant presence of exotic vegetation* | *-10* |
| *B. Shrub stratum (at less than 10 m from the wetland)* | |
| *a) Presence of autochthonous isolated trees* | *+5* |
| *b) Complete belt of autochthonous trees* | *+10* |
| *c) Presence of allochthonous isolated trees* | *-5* |
| *d) Complete belt of allochthonous trees* | *-10* |
| *e) Plantation (autochthonous or allochthonous)* | *-10* |
| *C. Water permanence* | |
| *a) Temporary wetland* | *+15* |
| *b) Permanent or semipermanent wetland of less than 30 cm of water depth* | *+10* |

| COMPONENT 5. Hydrophytic vegetation | Maximum – 20 points |
|---|---|
| 5.1. Quantity of submersed or rooted floating-leaf vegetation | |
| a) Absence | 0 |
| b) Presence (<25%) | 5 |
| c) Between 25 and 90% | 10 |
| d) Covers more than 90% of the wetland basin | 15 |
| 5.2. Quantity of non-rooted floating vegetation on the surface of the wetland | |
| a) Absence | 0 |
| b) Presence (<25%) | 3 |
| c) Between 25 and 90% | 5 |
| d) Covers more than 90% of the wetland surface | 0 |
| *Component 5 modifiers* | |
| *A. Communities of hydrophytic or floating-leaf vegetation* | |
| *a) Submersed or floating-leaf vegetation dominated by vascular plants or charophytes* | *+10* |
| *b) Community with similar abundances of filamentous algae and vascular plants or charophytes* | *+5* |
| *c) Community dominated by filamentous algae* | *-5* |
| *d) Community dominated by duckweed* | *-5* |
| *e) Allochthonous species abundant (>20%)* | *-10* |