A methodology for the evaluation of the biodiversity interest present in three terrestrial ecosystems in the Palma beach system

Una metodologia per a l'avaluació de la diversitat biològica d'interès present en tres ecosistemes terrestres en el sistema Platja de Palma

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Summary

An evaluation method for three terrestrial areas in the Palma beach system, Mallorca, Balearic Islands, Western Mediterranean is presented. Ses Fontanelles, Son Verí and Torrent dels Jueus are three fragments of semi-natural vegetation located within a very highly modified and exceedingly fragmented landscape. The Ratcliffe criteria (1977) were used as the basis for developing a multi-criteria decision making framework in order to score biodiversity value at sites. Ses Fontanelles is considered to be the area with the greatest biodiversity interest, followed by Son Verí and finally the Torrent dels Jueus. As biodiversity value is an important factor in conservation planning, it is hoped that the information presented in this study will assist in guiding urban planning decisions in this and similar areas.

Keywords: *Palma beach system, Ses Fontanelles, biodiversity, evaluation, Ratcliffe.*

Es presenta un mètode d'avaluació de tres àrees terrestres en el sistema de la Platja de Palma, Mallorca, Illes Balears, Mediterrània Occidental. Ses Fontanelles, Son Verí i el Torrent dels Jueus són tres fragments de vegetació semi-natural ubicat dins d'un paisatge molt modificat i fragmentat. Els criteris de Ratcliffe (1977) es van utilitzar com a base per al desenvolupament d'un marc de decisió multicriteri per tal de valorar la diversitat biològica en aquests llocs. Ses Fontanelles és considerada com la zona amb el major interès per a la biodiversitat, seguit per Son Verí i finalment pel Torrent dels Jueus. Com que el valor de la biodiversitat és un factor important en la planificació de la conservació, s'espera que la informació presentada en aquest estudi ajudi a prendre decisions sobre planificació urbana en aquesta i altres àrees semblants.

Paraules clau: *Platja de Palma, Ses Fontanelles, biodiversitat, avaluació, Ratcliffe.*

Introduction

The Mediterranean region is a hotspot for biodiversity and one of the world's prime tourist destinations (Myers et al., 2000). However, the land conversion process and the increased water demand associated with the growth of tourism have had considerable negative impacts for biodiversity conservation (Amelung & Viner, 2006). It is without doubt the coastal areas that have seen the highest rates of development, and Mallorca - receiving more than ten million tourists every year (IBESTAT, 2008) – currently registers almost one third (29%) of the coastline (considering the first 500m) as having an urban land use (Consell de Mallorca, 2008).

One of the principal areas of tourist activity is located within the Bay of Palma; it is known as the Palma Beach System and includes the urbanisations of S´Arenal and Can Pastilla. The area covers 10 km² and rests upon geological formations created during the Miocene and Pliocene epochs. The bedrock is calcareous in origin, with limestone and loamy soils characterising the zone (de la Cruz Caravaca et al., 2001), and the landscape is heavily marked by numerous temporary streams at run down into the Bay of Palma from both the Sierra de Tramuntana mountains and the Puig de Randa mountain (Eptisa, 1999). Natural ecosystems found within the zone include beach systems, wetlands, pine forest and garrigue. Due to the area's natural beauty, the tourist industry grew briskly from the 1960s onwards. Cheap, rapid development has characterised the area and the local, resident population of 34 000 is augmented by more then one million tourists every year (West 8, 2009).

With such high tourist interest there exists competition for land resources, thus nature conservationists have developed methodologies which aim to evaluate land for its present or potential biodiversity value. In this way, it is thought that biodiversity conservation can be promoted as a potential land use alongside other competing land uses, such as recreation, tourism and urban development. Also, as it has been widely proven that green spaces provide numerous physical, psychological, ecosystem service and recreational benefits (Attwell, 2000; Eliasson, 2000; Millard, 2000; Gómez et al., 2001), the protection and/ or restoration of certain areas is considered beneficial to the local population.

Therefore, the rational for this present study is to propose a suitable evaluation methodology and to employ this to determine the quality of the biodiversity interest in the remaining fragments of natural ecosystems found in the Palma Beach System.

A number of approaches have been developed to evaluate the biological value of an area. In 1974, the United Nations Educational and Scientific Committee (UNESCO) issued the first international guidelines designed to evaluate sites for inclusion in the new protected area, Man and Biosphere reserve system. The UNESCO set of criteria included the key tenets of diversity, rarity, naturalness and size and reflected the prevalent thinking of the day. Since then, various alternative methodologies have been developed. Many maintain the principal criteria included in the UNESCO plan, while developing additional points, such as a site's educational suitability (Gehlbach, 1975), number of structural plant formations (Van de Ploeg & Vlijm, 1978), intrinsic worth of resident species (Ehrenfield, 1976; Regan, 1981; Taylor, 1986; Gerowitt et al., 2003) or an evaluation of the site's historical contribution to artwork (Everett, 1978).

More recently, the emphasis has shifted towards environmental economics and the assignation of monetary values to the services or benefits offered by ecosystems. This was first formally proposed by Helliwell (1969) and many researchers have since developed this line of study (Kumari, 1994; de Groot, 1992; Costanza et al., 1997; Sathirathai, 1998; Balmford et al., 2002). It is a methodology often used by decision makers, who call for values to be expressed in monetary terms so that a cost benefit analysis can be utilised to assess the relative merits of different land use scenarios. In most recent years, United Nations based initiatives such as the Millennium Assessments (2005) and the Economics of Ecosystems and Biodiversity studies (TEEB, 2008) have worked on developing coherent economic evaluation methodologies. Yet some forty years on from when the first scientific evaluation methodologies were proposed and despite the plethora of literature and studies on the subject, there remains no one prevailing system used. Indeed, as much now as then, confusion arises from the multiplicity of criteria involved, and the broad range of conservation goals they reflect, many of these based on cultural values (Margulis & Usher, 1981; Rouquette, 2009).

For the present study, a methodology needed to be chosen and adapted to the current Balearic context. Previous work of this nature undertaken in the Balearic islands has concentrated on economic evaluation methodologies, such as cost benefit analysis (Riera, 1999), and contingent valuation (Cladera et. al., 2000). Cost benefit analysis is primarily used in areas with a recognised recreational use. However, this is not relevant to the study areas included here. Contingent valuation requires detailed survey based studies to ascertain the monetary value of specific goods and services to a population and such an investment of time and resources was considered beyond the scope of the present work. Therefore, these methods applied previously in the Balearic context were not considered appropriate for the goal of this particular study. Other economic based methodologies such as those used in the Millennium assessments and the TEEB studies were also discounted as being inappropriate. No one prevailing protocol is employed to complete such assessments, and the results, as with most economic evaluation studies of nature, are subject to much bias and controversy in the estimation of utilitarian values and preferences (Daily, 1997; Brauer, 2003; Woodroffe et al., 2005; McCauley, 2006). Further, as there has been no valuation of ecosystems services in this location before, an original valuation study would be certainly needed.

We thus decided that a more classic approach was appropriate, one where the weight of the evaluation was based on intrinsic values and not on socio-economic, utilitarian interest. The Ratcliffe method (1977) was chosen as the basis for developing the evaluation methodology. It develops upon concepts included in the UNESCO guidelines (1974), while elaborating six additional factors. It is the standard methodology employed by statutory agency Natural England in the United Kingdom for the evaluation of sites of special scientific interest, and is the longest standing evaluation methodology in practice in a European context (Natural England, pers. comm. 2010). Further, in a recent review by Rouquette et al., (2009) of seven different biodiversity evaluation methods, among which were included evaluations based on ecological impact assessment, stakeholder-choice analysis, and contingent valuation, the Ratcliffe criteria were defined as the most likely to attain objective results. No economic valuation is made of sites or ecosystem services; however, the criteria as adapted for this study allowed for some assessment of the public's perception of the sites under study.

Methods

The Study Areas

Ses Fontanelles (location: 39º32´05.92" N/ 2º43´41.60" E) is the last remnant of a lowland wetland area that historically covered a large part of the Bay of Palma (Amengual & Ramis, 2002). At just over 30 hectares, it is home to over 200 plant species, six dominant plant communities and one Mallorcan endemic sea lavender.

Son Verí (location: 39º29´22.44" N/ 2º45´04.48" E) represents approximately 83 hectares of traditional Mallorcan garrigue landscape. Divided into two by the MA 6014 main road, the lower part of Son Verí neighbours a residential area and sports centre, while the upper tract borders other garriga zones, agricultural land and a water waste treatment plant.

The Torrent dels Jueus (location: 39º30´12.38" N/ 2º45´38.62"E) passes through agricultural land before opening out into the Palma bay via the highly urbanised tourist nucleus of S´Arenal. It is an area with a moderate to high recreational use.

Data collection

The three sites were studied for a period of a year. Baseline data were gathered on plant species and communities, vertebrates and hexapods in April 2009. These were undertaken through completing series of transects that covered large areas of the sites. These were then monitored periodically throughout the subsequent 12 months. Standardised procedures were used throughout. Additional information on species presence was also incorporated into the study when not seen during transect studies. Aerial digital orthophotographs were also used to assist in the delineation of habitats. Randomly chosen points on the ground were then chosen to ground truth the estimates made.

Most taxonomical identification was carried out in the field. When this was not possible, independent naturalists were contracted. Plants were identified by means of botanical guides and also by contacting different plant specialists when a doubt emerged.

Son Verí was divided into 2 distinct areas. This was due to the perceived difference in levels of use and commensurate degradation observed in the two areas. The upper tract was denominated Son Verí 1 and the lower part, closer to the coastline, Son Verí 2. This also reflects a historical separation of the area (Font, 1972).

Evaluation methodology

Sites were assessed on ten different criteria: fragility, rarity, size, diversity, potential value, position within the ecological/geographical unit, representativeness, recorded history, naturalness and socio-cultural appeal. Evaluation scales were developed and sites were awarded points which were later converted into a five point scale. The evaluation scores for each criterion were then summed and reduced again to another five point scale. This score was then translated into an evaluation index.

The first nine criteria were assessed through information based upon data collection and literature reviews. The tenth and final criterion, an assessment of socio-cultural interest, was evaluated via a survey based methodology of the public participation, and is a deviation from the original Ratcliffe methodology, where the variable intrinsic appeal was assessed. In the context of this study, it was decided appropriate to include a socio-cultural criterion as it is recognised that public participation is desirable when identifying areas of nature conservation interest (Turnhout, et al., 2004; Schenk, et al., 2007), principally as a recognition of the importance of public participation in maintaining a site's integrity (Durrant & Shumway, 2004; Faasen & Watts, 2007; Dimitrakopoulos et al., 2010). The variables assessed in this criterion were chosen as being relevant to the local area and were considered not to require any previous scientific knowledge by survey participants. A total of 120 surveys were taken of local residents or workers in the Palma beach system. Another group of 30 surveys were taken of residents in each of the four areas. These were carried on Saturday mornings and afternoons as it was thought that this would be the most inclusive time for surveying in these areas. Surveys consisted of five questions, and participants

were asked to evaluate the study areas based on the perceived emblematic values of the resident species and habitats, pest species and aesthetic and recreational values. For each survey question, a scoring system was devised, a sum was made and a median taken for each of the five variables.

All ten criteria included in the methodology were given the same weighting in the final evaluation for the purposes of this study, given that the relative weight of one factor over another is difficult to understand in complex ecological systems (Robertson & Hull, 2001).

The methodology used provides a single numerical quantification of biodiversity interest for the four sites. The lower the overall score, the greater the interest a site has for conservation. If a site's overall score was deemed numerically equidistant between two distinct conservation status categories, the site was awarded the lower score, i.e. given the higher biodiversity value category. This was considered best practice as it is thought that continued data collection from sites, over a longer period of time would yield more biologically important components (Usher, 1986; Burbidge, 1991; Spellerberg, 1992) which would improve the overall assessment of biodiversity condition score and not diminish it.

An explanation of the scoring system devised is described below.

a). Fragility. The evaluation scale was based on the number and magnitude of factors that threaten the integrity of site. Each factor is assigned a score of either 1(lower) or 2 (higher), based on the magnitude of influence. The scores are summed and then related to an evaluation scale.

Translation of scores: I $\geq$ 8; II 6 – 7; III 4 – 5; IV 1 – 3; V 0.

Evaluation scale: I site is highly fragile; II very fragile; III fragile; IV some fragility; V not fragile in normal circumstances.

b). Rarity. Scalings are made based on an index calculated by the level of legislative protection given and the uniqueness of the genetic resources of the species protected.

Score for legislative protection: data deficient but with observed downward trends/locally protected, 1; national protection, 2; international protection, 3, e.g. International Union for the Conservation of Nature (IUCN) Red Lists or the Convention for international trade in endangered species (CITES Appendix 1).

Uniqueness of genetic resources: other species exist in the same genus 1, no other species in genus 5.

The two factors are multiplied together and a score calculated per species. The species scores are then summed with habitat scores.

Habitat scores: An additional 2 points are awarded for the presence of habitats classed as priority within the Red Natura system and an additional 1 point for habitats listed as of interest in Europe.

Translation of scores: I ≥ 35; II 25 – 34; III 15 – 24; IV 1 – 14; V 0.

Evaluation scale: I site possesses highly rare components; II very rare components; III significantly rare components; IV some rare components involved; V no rare species or habitats present.

c). Size (area or extent). Evaluation scale: I >100 ha; II 51–100 ha; III 30 – 50 ha; IV 11 – 30 ha; V <10 ha.

d). Diversity. Number of species are divided by number of ha to calculate average species per ha. These were then classified into high, medium and low diversity. A score of ≥5 species/ha receives a score of 3, 2 – 4,9 species/ha receive a score of 2, while <2 species per ha is awarded a score of 1.

Number of principal habitats located at a site are divided by number of ha to calculate average habitats per ha. A number of ≥0.12 habitats/ha receives a score of 3, 0.055 – 0.11habitats/ha receive a score of 2, while 0 – 0,054 habitats/ha is awarded a score of 1.

These two scores are summed. The result is then combined with a value assessing levels of degradation.

Sites showing considerable degradation receive an additional score of 1, some degradation 2, and little or none 3.

The three summed scores are then translated into an evaluation scale.

Translation of scores: I 8 – 9; II 6 – 7; III 4 – 5; IV 2 – 3; V 0 – 1.

Evaluation scale: I site possesses very important diversity components; II some important diversity components; III some notable diversity components; IV few diversity components; V no or very few notable diversity components.

e). Potential Value. Based on the following criteria, sites were awarded either a score of 1(low) or 2 (high) depending upon the level to which they meet the criteria.

1. Site is included or will be included in a protected area system

2. With informed management the area could be a unique component in the landscape matrix for its biodiversity interest

3. Provide opportunities for nature conservation education

4. Heterogeneity or possible adaptability of site permitting resilience to climate change

The three summed scores are then translated into an evaluation scale.

Translation of scores: I 7 – 8; II 5 – 6; III 3 – 4; IV 1 – 2; V 0.

Evaluation scale: I site possesses very high potential value; II reasonably high potential value; III some important potential value components; IV some possible potential value; V no potential value.

f). Position within the Ecological/Geographical Unit. Evaluation of the site is made by assessing its connectivity to the wider landscape matrix:

United to the wider landscape matrix – I

High potential to be united to the wider landscape matrix – II

Some potential to be united to the wider landscape matrix – III

Little potential to be united to the wider landscape matrix – IV

No potential to be united to the wider landscape matrix – V

Evaluation scale: I excellent geographical position; II good geographical position components; III moderate geographical position value; IV poor geographical position; V no observed positive component to geographical position.

g). Representativeness. Representativeness is assessed by making some measurement of the distinctiveness of the species and habitats in the site and whether they can be considered typical for the geographic region.

Evaluation scale: I sites maintain very important typical components; II some important typical components; III some notable typical components; IV some typical components; V no notable typical components.

h). Recorded History.

Excellent documentation available dating back to more than 100 years – I

Good documentation available dating back to more than 100 years – II

Some documentation available dating back to more than 100 years – III

Some documentation available about recent history – IV

No documentation available – V

Evaluation scale: I very good historical information; II good historical information; III some historic information available; IV little historical information; V no historical information.

i). Naturalness. Three scores are calculated and summed:

Level of human influence in the site: 1 high, 2 medium, 3 low or non existent

Number of native species: 1 low, 2 medium, 3 high

Current level of degradation: 0 very high, 1 high, 2 medium, 3 low

Translation of scores: I 8 – 9; II 6 – 7; III 4 – 5; IV 2 – 3; V 0 – 1.

Evaluation scale: I site possesses very important natural components; II some important natural components; III some notable natural components; IV few natural components; V no or very little notable natural components.

j). Socio cultural Appeal. Based on the following criteria, sites were valued based on surveys undertaken of people in the areas local to the sites.

In the surveys, five scores are calculated and summed:

1. Presence of habitats considered to have an emblematic value: 1 criterion poorly met, 2 criterion moderately met, 3 criterion strongly met

2. Presence of species considered to have an emblematic value: 1 criterion poorly met, 2 criterion moderately met, 3 criterion strongly met

3. Presence of species considered as pests or problematic: 1 two or more, 2 one, 3 none

4. Aesthetic value of the site: 1 low, 2 medium, 3 high

5. Local interest in using the site for recreation: 1 low, 2 medium, 3 high

Translation of scores: I 13 – 15; II 10 – 12; III 7 – 9; IV 4 – 6; V 1 – 3.

Evaluation scale: I site possesses very important socio-cultural appeal; II important socio-cultural appeal; III some notable socio-cultural appeal; IV little socio-cultural appeal; V no or very little socio-cultural appeal.

Results

Table 1 and Figure 1 illustrate the evaluation scores for the four study areas in each criterion and the overall score for all ten criteria.

Ses Fontanelles scores the lowest and this translates into the highest score for biodiversity interest. This relatively positive evaluation is due to the highly fragile nature of the site and the presence of a number of rare components, 11 in all, including one IUCN critical listed plant species, *Limonium barceloi*. Further, despite the low degree of naturalness present at the site, there is a very high diversity of plant species (220+) and of communities (6+). The site also receives a high score for being the remaining fragment of a previously much larger wetland extension and for its continuous presence in the historic record. It receives a low evaluation for geographic positioning as it is an ecologically isolated area, surrounded on all sides by main roads and urbanisations and it is also evaluated negatively for lack of socio-cultural appeal due to its perceived low aesthetic value and lack of emblematic habitats or species by surveyed participants. Despite this, it remains the site with the greatest interest for nature conservation.

Son Verí 1 is the area considered to possess the next most valuable biodiversity interest. This is in part due to its relatively pristine condition and extension but also due to its position within the wider

landscape and its intrinsic value. Mallorcan garrigue ecosystems are considered to be of value for their aesthetic and ecosystem service values. The aesthetic and emblematic value of the site was also recognised by surveyed participants.

Son Verí 2 is considered of lesser interest, as while it is a similar habitat type and size to Son Verí 1, its condition is inferior. Also, it shows less connectivity to the wider landscape than Son Verí 1.

Finally, the Torrent dels Jueus is a much degraded and much used recreation area. Despite this, it maintains an important conservation interest due to its geographical position. It has a potentially important position within the wider landscape matrix as a green corridor within and beyond the Palma beach system, as it permits connectivity with the mountainous region the Puig de Randa. This type of connectivity is considered particularly important in improving long term sustainability for animal and plant populations subject to the effects of climate change (Grabherr, et al., 1994; Burton, 2003; Konvicka et al., 2003).

For a detailed breakdown of how the methodology was applied to each site, see Tables 2-5.

Discussion

The methodology chosen was primarily concerned with how to successfully bring together information from several criteria and reduce this to a single index of evaluation for biological interest. It is considered that this was achieved with some success. However, in performing the analysis, difficulties arose, as the evaluation of some of the criteria, e.g. diversity or potential value require value judgements that must then be converted into numerical measurements. Some comment is made below on the problems considered inherent in the assessment of the sites based upon the criteria chosen.

Caveats with the methodology

a) Fragility. This is considered the best single measure of conservation value in a natural environment (Nature Conservancy Council, 1989; Nilsson & Grelsson, 1995). However, to adequately evaluate a site's

fragility, it is assumed that the dynamics and factors affecting the ecosystem/community in question are known. There are many causes of fragility, and each ecosystem will respond differently and natural areas may be vulnerable to change distant from the site itself. Furthermore, the scale utilised refers only to external factors and not the inherent fragility that an ecosystem could possess. Nor does the scale allow for the interaction of a combination of factors, so that for example, the presence of invasive species combined with the disturbance caused by climate change effects could result in a greater level of disturbance than two *other* factors acting together within the same time and space. This enhancement may also be dependent upon type of ecosystem, e.g. a forest may present greater resilience than a marshland (Miller & Hobbs, 2007).

b) Rarity. The definition of rarity is complex and cannot be given without reference to scale; one could refer to genetic rarity, species rarity or habitat rarity (Van de Maarel, 1978). All three were deemed worthy of evaluation in this context. Genetic rarity was assessed via the prioritisation of species that stand alone in their genus, and while this gives no exact quantification of the genetic rarity of the species in question it was considered adequate for this study. The species and habitat rarities were assessed through relating them to current legislation. Thus, if species or habitats were in some way protected, then they could be evaluated as rare components in the evaluation. However, legislation does not always adequately reflect the true conservation status of species, as often, sufficient data do not exist to evaluate it (Butchard et al., 2005: Good et al., 2006). Further, there may be species present at a site which fail to be registered through the monitoring procedures undertaken. Thus, this criterion is also a reflection of the survey intensity utilised.

c) Size. This measure plays a major part in determining the ecological interest of an area. A reduction in size of an area (e.g. through fragmentation) can reduce its nature conservation value considerably. Therefore, care must be taken when defining this criterion, as local context is very important. The evaluation scale chosen here reflects the Balearic island context, thus in Mallorca, 32 hectares is considered of moderate extension (Ses Fontanelles). In another context, an area of the same size could be considered small. Further, when defining the criterion, one must take into consideration the conservation interest that one wishes to protect and minimum viable populations should be considered. Obviously,

bears would need much larger areas than insects or plants (Beier & Noss, 1998). While the minimum viable area is generally known for the species resident in the study areas, the methodology does not take into account the range requirements of species in a climate change scenario.

d) Diversity. The diversity of a site can refer to (1) species diversity (species richness) and to (2) habitat diversity (richness in habitats, such as dune system, woodland, grassland and marsh). Both low and high diversity have a high nature conservation value under different circumstances. High species diversity would be important for areas such as herb-rich grassland or ancient woodland, whereas low diversity would be an important attribute for marshland or reed beds. It is not always a question of the greater the diversity the greater the value. Hence, this criterion alone is not an adequate measure of biodiversity value and must be considered alongside other criteria. Moreover, the condition and sustainability of diversity is an important factor to be considered. It is for this reason that a degradation index was incorporated into this evaluation criterion's design. Additionally, the species and habitat diversity indices were based on plant diversity. Resources limited a more extensive sampling of the remaining biota, so it was considered that levels of plant diversity reflect general levels of diversity at a site. However, ideally all species groups should be considered.

e) Potential value. Certain sites could, through appropriate management or natural change, develop a greater nature conservation interest. The realisation of this potential is dependent upon a number of factors, such as inclusion in a protected area system and/or management regime. Whether or not a site is important for its conservation education value can also contribute to its value and also the site´s adaptability to climate change will also affect its overall value in the long term.

f) Position within an ecological/geographical unit. As the probability for species survival in fragments has been correlated with the quality of the surrounding matrix (Fischer et al., 2005; Maiorano et al., 2008), the position of the site in relation to the surrounding landscape is considered an important measure of biodiversity value. However, this criterion is again very dependent on species and context. As stated before, sites for the conservation of mammals require greater connectivity than those for insects or birds (Beier & Noss, 1998). Thus, assessment should consider what biodiversity interest is to be conserved when measuring connectivity value.

g) Representativeness. As many other criteria that are ambiguous, representativeness requires an appropriate definition. It could be interpreted as a measure of the distinctiveness of species and habitats in geographic regions. It could also be perceived as a quantification of the extent to which a habitat conforms to a habitat type. Or it could be seen as the extent to which required natural features occur within a habitat (Anderson, 1991). In this study, we used the first definition as we considered that other criteria within the methodology make some assessment of the other two definitions. This may not always be the case, and adjustments may need to be made.

h) Recorded history. The history of a site is important, especially where a site is to be used for research and education. A well documented past with detailed biological and/or natural history records of species and habitat change presents a valuable insight into the ecology of the site, and such information can provide a basis for current and future management. However, the quality of the information must be assessed, so that proposed management actions based on this information have a sound basis.

i) Naturalness**.** The definition of the naturalness criteria is exceedingly complex, and there can be various definitions: (1) naturalness as that which is part of nature, (2) naturalness as a contrast to artificiality, (3) naturalness as an historical independence from human actions, and (4) naturalness as possession of certain properties. Further, these criteria could refer to species, habitats or processes (Anderson, 1991). In this study, three of the four definitions are incorporated into the evaluation. However, difficulties arise due to the highly modified nature of European habitats. In Europe, truly natural habitats, i.e. those unmodified by man are exceptionally rare; as the site of many early human civilisations, there has been heavy modification of the Mediterranean landscape during the last 10 000 years (Horden & Purcell, 2000). However, some measurement of naturalness must be made and thus, a historical benchmark is drawn at the advent of industrialisation. It is considered that this was a turning point, and from this date human actions in industrialised nations cease to fit within what can be called natural interaction with the landscape (Ridder, 2007). Therefore, habitats modified before this time are generally accepted to be natural. Son Verí 1, for example, is a classic example of Mediterranean garrigue, a habitat that only developed due to the deforestation of forested areas circa 1600, and as such is considered natural. In other regions of the world this concept of natural would not be accepted (Leard, 2004).

j) Socio-cultural appeal. There are numerous flaws inherent in this type of assessment. The variables utilised in this criterion were considered of relevance to the local area. However, as with all evaluations of nature by a general public, responses may reflect idiosyncratic cultural biases (Chai, 1997; Burchell, 1998, Kim, 2003) or be a reflection of the participant's socio-economic status (Swanwick, 2009). Also, it can not be guaranteed that the public who participate in the surveys are not being led by the question to a given response (Kalton & Schuman, 1982; Fowler, 1993; Patten, 2001) or are cognizant of the relevant information necessary to make a just evaluation (Scarpa et al. 2000, Novacek, 2008; Yasué et al., 2010). For example, a landscape considered aesthetically pleasing may not necessarily be associated with any perceivable ecological importance (Buijs, 2009). Indeed, it may be the contrary, such as a landscape full of attractive, exotic, invasive plants. This is clearly seen in this study, as participants in the survey were generally unaware of exotic plants being considered pest species.

Additional criteria. Other relevant additional criteria could include assessments of sites for their carbon emission/sequestration potential and/or climate regulation function.

Conclusion

In the current socio-politic-economic environment, it is necessary to choose from among remaining natural sites, those that are the most valuable for conservation. Methodologies must therefore be developed that assist the evaluation of different sites. Despite the difficulties encountered in the application of the methodology presented here, it is considered that the Ratcliffe criteria (1977) and the scalings developed for this study were appropriate and useful in the present context. Thus, we elucidated that of the three areas studied in the Palma beach system, Ses Fontanelles is the area with the highest biodiversity interest, as the site is deemed to have a medium to high conservation value. Son Verí 1 is considered the site with the next most important biodiversity interest, while Son Verí 2 and the Torrent dels Jueus score equally as having a medium to low biological interest. It is hoped that this information and/or the methodology developed may be of use to conservationists and urban planners.

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Tables and Figures

Criteria	SF	SV -1-	SV -2-	TJ
Fragility	1	4	4	4
Rarity	3	4	5	5
Size	3	3	3	4
Diversity	2	3	4	4
Potential valor	2	3	4	3
Position	4	2	3	2
Representativeness	2	2	4	4
Documented history	2	4	4	4
Naturalness	3	3	3	4
Intrinsic appeal	3	1	2	2
TOTAL	**25**	**29**	**36**	**36**
Conversion to 5 point evaluation scale	**2**	**3**	**4**	**4**

Table 1. Evaluation scores for the four areas. (SF) Ses Fontanelles, (SV1) Upper Son Verí, (SV2) Lower Son Verí, (TJ) Torrent dels Jueus.
Taula 1. Avaluació de les quatre àrees. (SF) Ses Fontanelles, (SV1) Son Verí superior, (SV2) Son Verí baix, (TJ) el Torrent dels Jueus.

<table>
<tr><th>Criteria</th><th>Ses Fontanelles</th><th>Score</th></tr>
<tr><td>Fragility</td><td>Maintenance of the system is dependent on the hydrological regime. 2
The area suffers high urban development pressure. 2
Predicted impacts of climate change expected to affect salinity and water levels. 2
Large number (>20) of invasive species. 2
Sum of scores: 8</td><td>I
(highly fragile)</td></tr>
<tr><td>Rarity</td><td>
<table>
<tr><th>Species or Habitat</th><th>Level of protection</th><th>Uniqueness</th><th>Score</th></tr>
<tr><td>Limonium barceloi (Gil & Llorens, 1991)</td><td>3 (IUCN Red list, 2008)</td><td>1</td><td>3</td></tr>
<tr><td>Tamarix spp L.</td><td>1 (Balearic Catalogue, 2005)</td><td>1</td><td>1</td></tr>
<tr><td>Ardeola ralloides (Scopoli, 1769)</td><td>2 (National Catalogue, 2005)</td><td>1</td><td>1</td></tr>
<tr><td>Chlidonias niger (Linnaeus, 1758)</td><td>2 (National Catalogue, 2005)</td><td>1</td><td>2</td></tr>
<tr><td>Falco tinnunculus (Linnaeus, 1758)</td><td>2 (CITES)</td><td>1</td><td>2</td></tr>
<tr><td>Numenius arquata (Linnaeus, 1758)</td><td>2 (National Catalogue, 2010)</td><td>1</td><td>2</td></tr>
<tr><td>Rallus aquaticus (Linnaeus, 1758)</td><td>1 (Balearic Catalogue, 2005)</td><td>1</td><td>2</td></tr>
<tr><td>Tringa totanus (Linnaeus, 1758)</td><td>1 (Balearic Catalogue, 2005)</td><td>1</td><td>2</td></tr>
<tr><td>Vanellus vanellus (Linnaeus, 1758)</td><td>1 (Balearic Catalogue, 2005)</td><td>1</td><td>2</td></tr>
<tr><td>Limonetalia habitat
(de la Cruz, 2009)</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>Sarcocornietum fructicosae (Bolòs i Capdevila, 1996)</td><td>-</td><td>-</td><td>1</td></tr>
<tr><td colspan="3">TOTAL</td><td>20</td></tr>
</table>
</td><td>III
(Significantly rare components)</td></tr>
</table>

Size	Area en hectares Approx. 32.8	III (Moderate extension in this context)
Diversity	220 plant species (Khan & Traveset, 2009). Species per hectare: 5.5. Relevant score: 3 At least 6 dominant plant communities. Community per hectare: 0.15. Relevant score: 3 Sum of scores 6.	II (Some important diversity components)
Potential value	Part of the site will be included in the protected area system via the designation of an "ABC" or Critical Biological Area. 1 Would be a unique component in the local landscape matrix. 2 Could provide excellent opportunities for nature conservation education, due to its biodiversity and location. 2. Sum of scores: 5	II (Reasonably high potential value)
Position within the Ecological/Geographical Unit	A relatively isolated fragment of natural space, bordered by two main roads and a motorway. An airport is located close by and the remainder of the immediate area is heavily urbanised. There is currently little potential for connectivity. 4	IV (Little potential to be united to the wider landscape matrix)
Representativeness	As the only remaining fragment of a much larger wetland extension, the area is considered to present highly important representativeness components.	I (Very important typical components)
Recorded history	The first mention of the area now known as Ses Fontanelles, could possibly date back to the year 1144, when reference is made to a small cala next to Sant Jordi. Later, in the 16th century mention is made of the lagoons of Sant Jordi which almost certainly include the areas of Ses Fontanelles and there is some detail of the plant and animal communities present at that time (Amengual & Ramis, 2002). Since then, the zone continues to reappear in historical literature and was the site of a great public drainage project. Later, in the 20th century there are a number of historic photos and documents for the area.	II (Good documentation available dating back to more than 100 years)
Naturalness	High level of human influence. 1 Medium number of native species. 2 High level of degradation. 1 Sum of scores: 4	III (Some notable natural components)
Socio-cultural appeal	Some habitats of emblematic value. 1 Some species of emblematic value. 1 One problematic species. 2 Low aesthetic value due to presence of refuse. 1 High recreational interest in site due to location. 3 Sum of scores: 8	III (Some notable socio-cultural appeal)
	TOTAL	**24**

Table 2. Evaluation of the biodiversity value of Ses Fontanelles according to the Ratcliffe criteria (1977).

Taula 2. Avaluació de Ses Fontanelles d´acord amb els criteris Ratcliffe (1977).

<table>
<tr><th>Criteria</th><th>Son Verí 1</th><th>Score</th></tr>
<tr><td>Fragility</td><td>The area suffers some recreational pressure. 1

Sum of scores: 1</td><td>IV (Some fragility)</td></tr>
<tr><td>Rarity</td><td><table>
<tr><td>Species or Habitat</td><td>Level of protection</td><td>Uniqueness</td><td>Score</td></tr>
<tr><td>Cneorum tricoccum L.</td><td>-</td><td>5</td><td>5</td></tr>
<tr><td colspan="3">TOTAL</td><td>5</td></tr>
</table></td><td>IV (Some rare components involved)</td></tr>
<tr><td>Size</td><td>Area en hectares
Approx. 24 hectares</td><td>III (Moderate extension in this context)</td></tr>
<tr><td>Diversity</td><td>84 plant species (Khan & Traveset, 2009).
Species per hectare: 3.5. Relevant score: 2
At least 3 dominant plant communities. Community per hectare: 0.125. Relevant score: 3

Sum of scores 5.</td><td>III (Some notable diversity components)</td></tr>
<tr><td>Potential value</td><td>Would be a unique component in the local landscape matrix. 1
Could provide excellent opportunities for nature conservation education, due to its biodiversity and location. 1
Resilience to climate change. 1
Sum of scores: 3</td><td>III (Some important potential value components)</td></tr>
<tr><td>Position within the Ecological/Geographical Unit</td><td>Bordered on one side by a main road, there exist few other boundaries that cause to separate the area from the surrounding landscape matrix, which extends far beyond the Palma Beach System. While most of this matrix is agricultural land, Son Verí includes a torrential stream which provides connectivity with the area around the Puig de Randa.</td><td>II (High potential to be united to the wider landscape matrix)</td></tr>
<tr><td>Representativeness</td><td>The habitats found here are those usually associated with Mediterranean scrubland landscapes and as such are considered to be very typical. However, as they are principally the result of the anthropogenic degradation of Quercus forests, their presence is relatively recent, dating back to 5 000 years maximum.</td><td>II (Some important typical components)</td></tr>
<tr><td>Recorded history</td><td>First mention of Son Verí dates back to the year 1563 when the site was referred to as part of a much larger traditional farm holding with the same name. There is some historical inventory of farm animals and crops managed on the land. (Font, 1972)</td><td>IV (Some documentation available about recent history)</td></tr>
<tr><td>Naturalness</td><td>High level of human influence. 1
Medium number of native species. 2
High level of degradation. 1
Sum of scores: 4</td><td>III (Some notable natural components)</td></tr>
<tr><td>Socio-cultural appeal</td><td>Some habitats of emblematic value. 2
Some species of emblematic value. 2
No problematic species. 3
High aesthetic value. 3
High recreational interest in site due to location. 3
Sum of scores: 13</td><td>I) (Very important socio-cultural appeal)</td></tr>
</table>

	TOTAL	**29**

Table. 3. Evaluation of Son Verí 1 according to the Ratcliffe criteria (1977).

Taula. 3. Avaluació de Son Verí 1 d´accord amb els criteris Ratcliffe (1977).

Criteria	**Son Verí 2**	**Score**
Fragility	The area suffers recreational pressure. 2 Presence of invasive species. 1 Sum of scores: 3	IV (Fragile)
Rarity	No rare components found	V (No rare species or habitats present)
Size	Area en hectares Approx. 59 hectares	II (Reasonably sized extension in this context)
Diversity	70 plant species (Khan & Traveset, 2009). Species per hectare: 1.186. Relevant score: 1 At least 3 dominant plant communities. Community per hectare: 0.05. Relevant score: 1 Sum of scores 2.	IV (Few diversity components)
Potential value	Could provide excellent opportunities for nature conservation education, due to its biodiversity and location. 1 Sum of scores: 1	IV (Some important potential value)
Position within the Ecological/Geographical Unit	Bordered on three sides by roads, a housing urbanisation and a sports centre, the area has little direct connection with the surrounding landscape matrix although two underground concrete tunnels connect Son Verí 1 and 2.	III (Some potential to be united to the wider landscape matrix)
Representativeness	The habitats found here are those usually associated with Mediterranean scrubland landscapes and as such are considered to be very typical. However, as they are principally the result of the anthropogenic degradation of *Quercus* forests, their presence is relatively recent, dating back to 5 000 years maximum.	IV (Some typical components)
Recorded history	First mention of Son Verí dates back to the year 1563 when the site was referred to as part of a much larger traditional farm holding with the same name. There is some historical inventory of farm animals and crops managed on the land (Font, 1972).	IV (Some documentation available about recent history)
Naturalness	High level of human influence. 2 Medium number of native species. 2 High level of degradation. 3 Sum of scores: 7	III (Some notable natural components)
Socio-cultural appeal	Some habitats of emblematic value. 2 Some species of emblematic value. 2 Presence of problematic species such as numerous invasive species. 3 High aesthetic value. 2 High recreational interest in site due to location. 3 Sum of scores: 12	II) (Important intrinsic appeal)
	TOTAL	**36**

Table. 4. Evaluation of Son Verí 2 according to the Ratcliffe criteria (1977).

Taula. 4. Avaluació de Son Verí 2 d´acord amb els criteris Ratcliffe (1977).

Criteria	Torrent dels Jueus	Score
Fragility	The area suffers recreational pressure. 1 Presence of invasive species. 2 Sum of scores: 3	III (Fragile)
Rarity	No rare components found	V (No rare species or habitats present)
Size	Area en hectares Approx. 28 hectares	IV (Reasonably small extension in this context)
Diversity	80 plant species (Khan & Traveset, 2009). Species per hectare: 2.857. Relevant score: 2 At least 2 dominant plant communities. Community per hectare: 0.07. Relevant score: 2 Sum of scores 4.	III (Some notable diversity components)
Potential value	Could provide excellent opportunities for nature conservation education, due to its biodiversity and location. 2 Resilience to climate change. 1 Sum of scores: 3	III (Some important potential value)
Position within the Ecological/Geographical Unit	While bordered by urbanisations, thus limiting connectivity within the Palma beach system, the upper tract of the torrent connects to the lower reaches of the Puig de Randa.	II (High potential to be united to the wider landscape matrix)
Representativeness	Despite being a torrent, there exists little of the vegetation normally associated with this habitat. A high number of invasive species are present and this combined with the large number of common nitrophilic species means that this zone maintains little that could be termed typical..	V (No typical components)
Recorded history	Some information available in local history documentation (Promallorca, 1991).	IV (Some documentation available about recent history)
Naturalness	High level of human influence. 1 Medium number of native species. 2 High level of degradation. 0 Sum of scores: 3	IV (Few natural components)
Socio-cultural appeal	Some habitats of emblematic value. 2 Some species of emblematic value. 1 Presence of problematic species such as numerous invasive species. 3 High aesthetic value. 2 High socio cultural interest in site due to location. 3 Sum of scores: 11	II) (Some important socio-cultural appeal)
	TOTAL	**36**

Table. 5. Evaluation of the Torrent dels Jueus according to the Ratcliffe criteria (1977).

Taula. 5. Avaluació del Torrent dels Jueus d´accord amb els criteris Ratcliffe (1977).

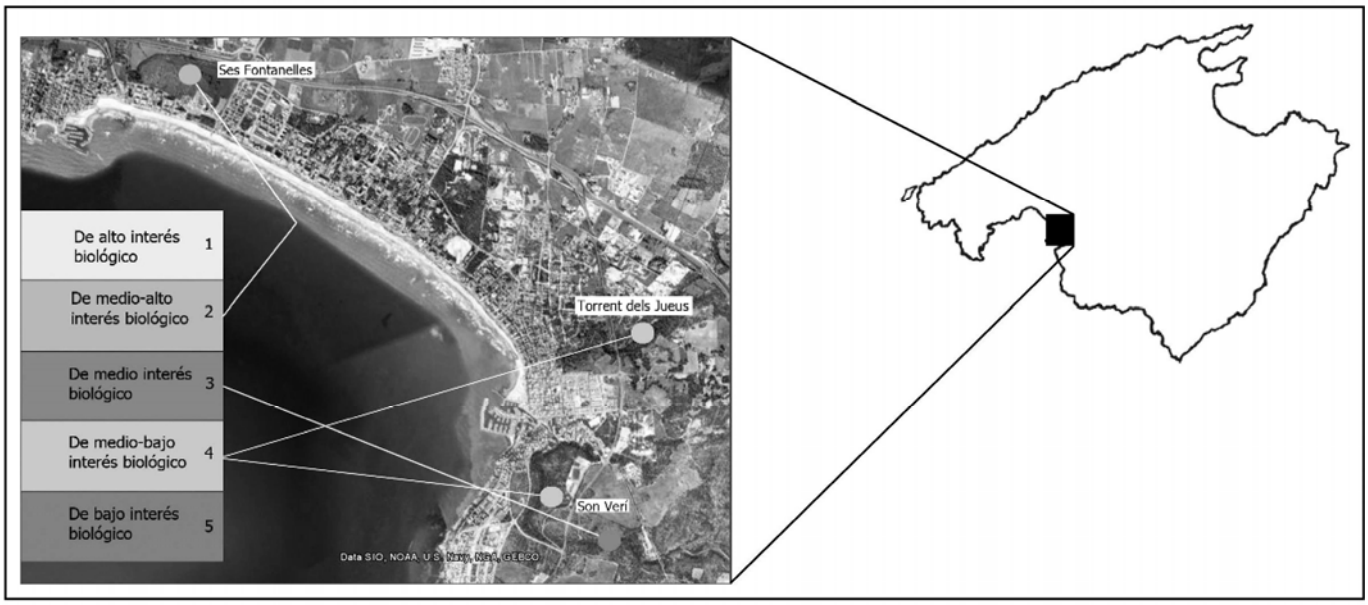

Fig. 1. Relationship of evaluation scale to biological interest for the study sites.

Fig. 1. Relació de l'escala d'avaluació d'interès biològic als llocs d'estudi.