Article

Cultural Ecosystem Services in the Natura 2000 Network: Introducing Proxy Indicators and Conflict Risk in Greece

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Abstract: Within the ecosystem services framework, cultural ecosystem services (CES) have rarely been applied in state-wide surveys of protected area networks. Through a review of available data and online research, we present 22 potential proxy indicators of non-material benefits people may obtain from nature in Natura sites in Greece. Despite the limitations due to data scarcity, this first distance-based study screens a recently expanded protected area system (446 Natura sites) providing steps towards an initial CES capacity review, site prioritization and data gap screening. Results identify hot spot Natura sites for CES values and wider areas of importance for the supply of CES. Additionally, a risk analysis mapping exercise explores the potential risk of conflict in the Natura sites, due to proposed wind farm developments. A number of sites that may suffer serious degradation of CES values due to the large number of proposed wind turbines within these protected areas is identified, with 26% of Greece's Natura sites showing serious and high risk of degradation of their aesthetic values. Screening-level survey exercises such as these may play an important role in advancing conservation effectiveness by increasing the appreciation of the multiple benefits provided by Natura protected areas. Based on this review, we propose recommendations through an adaptive approach to CES inventory and research initiatives in the protected area network.

Keywords: protected areas; ecosystem services; recreation; landscape; mapping; wind farms; conflict

1. Introduction

Many Natura sites have high cultural values and these have often been overlooked and ignored within biodiversity conservation [1]. In the ecosystem services (ES) framework, the non-material benefits nature provides to humans are analyzed through cultural ecosystem services (CES) [2,3]. CES include a wide range of benefits that the natural environment provides for people; direct and indirect values pertaining to culture, heritage, education, recreation, tourism, aesthetic, religious and spiritual attributes. Various CES analyses have been utilized in many applications, including studies of landscapes and seascapes [4–7]. However, few CES applications focus on protected area networks [8–10], and CES indicators at these broader scales, such as regional scales, are variously defined and not consistent [11–14].

Building indicators for assessing CES has proven challenging [15,16]. Standardized CES indicators should provide aggregated information on the non-material benefits available to humans from nature to help summarize and evaluate complex human–environmental relationships [17]. Compared to other ecosystem services approaches, CES are especially difficult to quantify [18], often differentially interpreted by different beneficiaries and stakeholders [19] and sometimes hard to depict in cartography [20,21]. They are, therefore, generally poorly represented in existing ecosystem service assessments [11,22,23]. Recently,

controversy was sparked with respect to a proposal to actually omit CES *per se* from routine ecosystem services valuations [24,25]. However, despite differing opinions and methodological challenges, the ecosystem services framework is now a widely applied standard assessment platform and it has shown to be effective in mission-orientated evaluation, communication and policy support [7,26]. There is little doubt that CES applications will continue to be developed, tested and promoted, even at the challenging broad spatial scales of geographical regions and nations (e.g., [9,27–29]).

Despite its growing pains, CES have recently been shown to be important and useful in protected areas, especially because cultural conditions, including local communities, local world-views and policy directives create and sustain protected areas [8,9,30]. Protecting CES in protected areas is often directly associated with maintaining human wellbeing and sustainability. The expectations placed on protected areas by a variety of stakeholders have increased beyond classical biodiversity demands, as these "sanctuaries" are becoming testing grounds for sustainability [31–34]. The Natura 2000 protected area network, the EU's conservation centerpiece, has seen increased interest for more cultural and sustainability demands [35,36]. In this context, conservation and management plans must go beyond specific biodiversity targets.

Conservation in protected areas has been a difficult undertaking in the Mediterranean EU states [37]. Mediterranean protected areas usually have multiple functions, and conservation management is often a perpetual challenge. The Mediterranean's landscapes have evolved as complex socio-ecological systems with a strong interdependence among past and present land-uses [38]. The ecological integrity of many Natura sites is strongly influenced by centuries-old human–nature interactions that affect landscape-scale dynamics and are driven by the life-ways and attitudes of people, especially local communities [19,39,40]. The number of designated protected areas has expanded quickly; in Greece, for example, 28% of land territory has been designated as Natura sites in less than three decades. However, Protected Area conservation management has received much "bad press" in Greece; there have been serious organizational difficulties and noticeable shortcomings [41,42]. Greece's protected areas, in need of reform and effective conservation actions, may provide a good model to explore CES protected area network assessments.

In Greece, CES applications are new and rarely used in protected area management. Among the recently published National Mapping and Ecosystem Services Assessment (MAES) initiative [43], few indicators track a breadth of possible CES attributes. Kokkoris and colleagues in 2020 [43] emphasize that new CES indicators must be tested and developed to complement the initial proposed national indicators. Baseline knowledge gaps and data scarcity have long been known to be serious hurdles for effectively protecting the Natura sites in Greece [44]. Greece's protected area system still shows developmental difficulties [45]. An example of this includes recent policy changes: in May 2020, a new Modernization of the Environmental Legislation bill was passed (Law 4685/2020), which drew strong resistance from many environmentalists [46]. Some of the difficulties in Greece may be related to the post-2008 economic recession, while others to long-term land-use conflicts and competition for a variety of resources and poor government coordination [47,48]. Greece has not developed an integrated national protected area monitoring system [48], and the full set of values associated with the protected sites are usually poorly acknowledged. Although some of Greece's efforts for species or habitat preservation are commendable [42], many other aspects such as the protection of its designated Areas of Outstanding Beauty, wilderness areas and cultural landscapes are considered inadequate, and preservation measures are poorly enforced [49–53]. The continuing degradation of Greece's protected areas, including its scenic and iconic landscapes, could have serious social and economic impacts.

Greece's protected areas are of outstanding value for biodiversity, but focusing solely on biodiversity is plainly not enough for successful conservation. In Greece, a variety of CES should be inventoried and assessed as soon as possible, to enable better integration of an array of services and benefits within the national ES-based assessment framework [43].

Understanding and communicating the cultural aspects in protected areas is important for promoting a more transparent and socially sensitive science–policy interface [36,54], and one reason for socially sensitive steps in conservation is conflict risk management [55].

In this study we undertake a CES geographical survey in Greece and explore its practical use in a case study where potential conflict may exist with proposed industrial wind farm developments in the Natura 2000 protected area network. In an attempt to provide a rapid broad-scale CES application under currently data-scarce conditions, we utilize proxy indicators. Proxies provide indirect measures that approximate or may represent a phenomenon in the absence of a direct measure, and they are now widely used in the social sciences and in interdisciplinary research [56]. We evaluate the Natura 2000 network with reference to the cultural services provided by the Natura site qualities using available and accessible databases and metadata from recent screening-level surveys and online research. Approaching CES evaluation through this "low hanging fruit" procedure (i.e., rapid, easily available data-gathering) provided an initial screening of potential indicators, in an attempt to introduce the concept of CES and its practical uses in the country's protected area system.

2. Materials and Methods

2.1. The Protected Area System

Greece's protected area system is mainly based on areas designated under the EU Natura 2000 ecological network [57]. There are other "protected areas" such as the former no-hunting zones (now called "wildlife refuges"), many of which are not within the Natura 2000 network. Older designated natural heritage protected areas (such as the National Parks and Aesthetic Forests) are usually within the network. In practice, few management and conservation interventions are made with concern for designated natural heritage areas outside the Natura 2000 network. During the last decades, institutional biodiversity management focus has been on Natura 2000, especially since EU policies monitor the country's progress [58]. Greece's Natura 2000 network includes sites that are characterized for their avifauna as Special Protection Areas (SPAs) and sites that are characterized as Special Areas for Conservation (SACs) for their habitat types, flora and other fauna species under the EU Directives 2009/147 and 92/43, respectively. In combination, Greece currently maintains 446 such Natura sites (some SPAs and SACs partly overlapping) and some newly delineated areas still considered Sites of Community Interest (SCIs) or proposed SCIs. The Natura 2000 network has been expanding in Greece since the first listing of sites in 1995, after the inclusion of several new proposed SCIs in late 2017 (including many new Marine sites).

2.2. Preparatory Actions and CES Indicator Selection

The initial overview of potential CES indicators involved the following steps:

1. Literature review for CES indicators in Greece: building on a potential list of CES indicators used for the site-level assessment of ES supply at mountainous Natura sites in Greece [59] and indicators proposed for the National MAES indicators [43].
2. Compilation of data and GIS map layers pertaining to the Natura sites in Greece: using the Natura 2000 Standard Data Forms and monitoring results [60] and spatial data for habitat types following the European Environment Agency (EEA) guidelines [61]; a detailed ecosystem-type mapping for Greece is an ongoing procedure of the LIFE-IP 4 NATURA project [43].
3. Protected-area cultural attributes data matrix and associated metadata pertaining to Natura 2000 "culturalness" developed by Vlami and colleagues in 2017 [62].
4. Exploration of data availability and quality with respect to the state-wide relevance of national indicators for MAES applications based on the review by Dimopoulos and colleagues in 2017 [44] and on datasets freely available by state authorities (links provided in Kokkoris and colleagues in 2020 [43]).

5. Selection and review of indicators responsive to policy and conservation management needs: using the guidance provided by Maes and colleagues [63,64] and in combination with the targets of the Greek Biodiversity Strategy [65]; each indicator was examined for policy relevance and related to the Common International Classification for Ecosystem Services (CICES) [66].

6. Initial assessment of potential indicators: using a simple scaling method, based on van Oudenhoven [67], pertaining to salience, credibility, legitimacy and feasibility. Each potential CES indicator was scored by the co-authors as: 1—very low, 2—low, 3—medium, 4—high, 5—ready for use. This overview of uncertainty of use allowed the co-authors to decide on a final selection of potential indicators and to explore uncertainty and applicability issues. This screening of indicators is identical to building the national MAES indicators [43].

2.3. Database and Mapping Applications

For the identification and mapping of features within each protected area we applied the work method developed by Vlami and colleagues in 2017 [62] to create a relational database that has been linked to Natura sites' spatial data (site polygons) using a Geographical Information System (QGIS) platform [68]. To produce gradient hotspot maps, the total value of each area (site) has been linked to the relevant Natura 2000 spatial data (protected area vector polygons). Using the QGIS platform, the protected sites of Greece were differentiated and thematically presented as hotspots in gradient maps (i.e., hot = high total attribute sum of scores; cold = low total attribute sum of scores). Heat maps were also produced by using the centroids of each Natura site. Each centroid has been assigned the total site value, and this attribute information was used as the weighting factor for each site. The active radius used for creating heat maps varied with the particular use of each map. Combined indicators' gradient and heat maps are created by summing standardized (0–1) values of the relevant categories; gradient maps thematically represented the result to a five-rating scale (i.e., very low, low, moderate, high, very high); heat maps depict the vicinity (concentration in space) of Natura sites throughout the Greek territory.

A challenge in this application was dealing with poor data quality, data scarcity and inconsistency in data quality. In the initial survey, efforts were taken not to complicate or confound the collected data attributes through integrative techniques, since the attributes and the quality of data accuracy in the matrix is heterogeneous (i.e., with varying degrees of quality and precision). The evaluation by the authors assisted in checking the relative quality of the data used, by evaluating this through the co-authors' expert judgment.

Based on the literature review, five categories of potential proxy indicators were decided upon (Figure 1, Table 1). Specific indicators were chosen and maps were developed for nearly all of them.
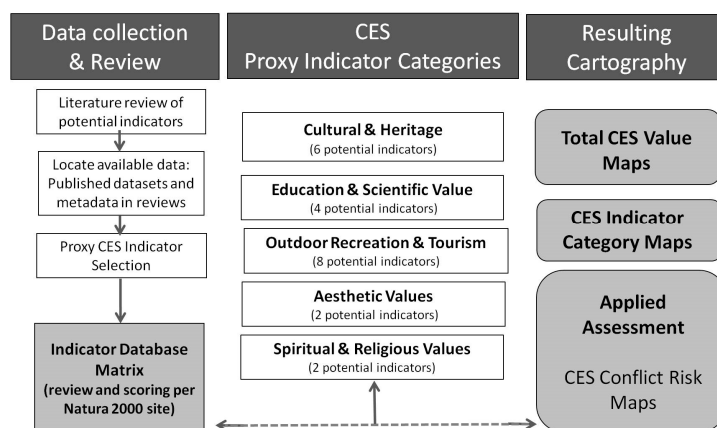
Figure 1. Schematic representation of the cultural ecosystem services (CES) rapid assessment approach.

Table 1. List of 22 CES proxy indicators selected in this application.

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
1. Culture and Heritage	1. Protected Area Archeological Value	Archeological value based on number and significance of sites within the protected area [62]	Sites of salient cultural heritage and relic monuments from pre-history to 1830. Source: Pleiades database/Metadata	3.1.2.3 (heritage, cultural)	5—ready for use. Salient inventory of designated archaeological sites. However, many archeological sites are not well delineated with exact areal boundaries
	2. Protected Area Traditional Settlement	Value of protected area based on designated traditional settlements within protected area boundaries [62]	Preserved structure of settlement; outstanding interest for heritage value. Source: Metadata	3.1.2.3 (heritage, cultural)	5—ready for use. Designated sites have been identified; however the designation registry is not considered complete
	3. Protected Area Traditional Farming	Importance of protected area based on area given to traditional farming practices in protected area [62]	Small-scale farming methods maintained; potentially including high nature value farming areas. Source: Metadata	3.1.2.3 (heritage, cultural)	3—medium. Uncertainty exists in defining areas with objective criteria; no baselines available doing this rapidly in a feasible manner
	4. Protected Area Working Village	Presence of villages within the protected area	Small-scale or other farming/grazing maintained present. Source: Metadata	3.1.2.3 (heritage, cultural)	4—high. Relation to CES values not always legitimate; some villages relate to living rural settlements that provide high nature value farming

Table 1. *Cont.*

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	5. Protected Area Mythical Places	Mention of the site in classical mythology	Historic non-material place-values. <u>Source</u>: Metadata	3.2.1.1 (symbolic)	3—medium. Reference currently based on a single study (Olalla 2002 in Metadata)
	6. Protected Area High Culturalness	Over 50% protected Area covered by cultural land cover and/or culturally modified habitat types [62]	Areas of outstanding biodiversity values dominated by human-altered habitat types (i.e., designated biodiversity rich cultural landscapes). <u>Source</u>: Metadata	3.1.2.3 (heritage, cultural)	3—medium. Habitat type delineations differ markedly from Corine land cover delineations Difficult to be certain about baselines; difficult to map with precision and consistency
2. Nature-Based Education and Scientific Value	7. Environmental Education Centers	Government-run education centers for schools and continuing education	Government-enacted schooling-oriented facilities; refers to nodes of environmental education activities pertaining to natural areas in the vicinity. <u>Source</u>: Online Survey (This study)	3.1.2.2 (educational)	3—medium. Education centers often created by political decisions and relative to educational or other socio-economic interests. Inconsistent in terms of how these centers and associated activities relate with CES attributes of site

Table 1. *Cont.*

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	8. Environmental Information Centers	All types of "nature center" facilities, such as information centers in protected areas, special and specialized exhibits and events that focus on nature awareness, conservation education and scientific dissemination of research and natural history promotion in general	Usually direct connection to natural areas in the vicinity. In order for state authorities to build such an information center, specific interests and values exist in the vicinity. Source: Online Survey (This study)	3.1.2.1 (scientific), 3.1.2.2 (educational)	4—high. Mostly related to protected areas and an important infrastructure for tourism and education. Often within or very close to protected areas. However, some of the mapped infrastructure is no longer functioning (not maintained or no longer open to the public)
	9. Birdwatching Hotspots	Metadata has been adapted to show top areas with interest for birdwatching and associated ecotourism as extracted from citizen scientists' data on the ebird website. (All hotspots are presented; however, sites with >100 tallied species are counted as double)	Most attractive locations to amateur naturalists observing birds. The indicatum refers to the value of these areas for their supply of wildlife watching experiences to people. Source: ebird Database (This study)	3.1.2.1 (scientific), 3.1.2.2 (educational)	5—ready for use. Crowd-sourced data that undergoes quality controls and updated regularly. This is a very good indicator of general wildlife watching hotspot areas

Table 1. *Cont.*

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	10. Symbolic Places	Designated National Parks (including National Forest Parks). These comprise 24 sites, including former National forest parks and all recently enacted marine and wetland national park designations	Outstanding and culturally prized sites that have been identified and pegged as outstanding international-scale conservation and nature-promotion areas. Source: Survey (This study)	3.1.2.1 (scientific), 3.1.2.2 (educational)	3—medium. Of the potential symbolic places; the highest form of designation (National Parks/National Forest Parks) provides a proxy for long-term interest in preservation as sites of symbolic interest. Indicator limited to rather few sites
3. Outdoor Recreation and Tourism	11. Trail Walking	Proximity to important trail walking area.	Areas used often by local or visiting recreationists. Source: Online Survey (This study)	3.1.1.2 (physical use)	4—high. Important as potential indicator but inventory of all trail walking facilities does not exist
	12. Inland Rafting and Boating	Top popular rafting sites and sightseeing boating sites	A resource-scarce and popular adventure-tourism and recreational activity, requiring wild and large river and lake water bodies. Source: Online Survey (This study)	3.1.1.2 (physical use)	5—ready for use. A limited area/river length is available in Greece making this indicator area credible, legitimate and feasible. Indicator limited to rather few sites

Table 1. *Cont.*

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	13. Ski Resorts	High elevation winter tourism centers. This is rather scarce in Greece	Tourism development that showcases high large sub-alpine/alpine environment. Source: Online Survey (This study)	3.2.1.3 (entertainment) 3.1.1.2 (physical use)	3—medium. Not salient since facility development is based on other factors for such developments. Very feasible, since resort sites limited
	14. Thermal Springs	Natural thermal springs; sites open to public	A resource-scarce environment popular with health-related tourism and recreation. Source: Online Survey (This study)	3.1.1.2 (physical use)	5—ready for use. A specific and large number of sites are salient attractions. This indicator seems credible, legitimate and feasible
	15. Blue Flag Beaches	Distinguished and awarded by the Europe-wide conservation initiative blue flag beaches	Particularly cherished, well-managed or attractive beaches. Source: Online Survey-Blue Flag Designated sites 2018	3.2.1.3 (entertainment)	3—medium. Salience and credibility vary as do legitimacy. Awarding blue flags to a site has socio-political parameters not just related to ecosystem services
	16. Organized Camping Sites	Sites open to public (in Greece used during summer holidays)	Areas chosen for long-term summer holidays in the countryside, near attractive recreational locations. Source: Online Survey (This study)	3.2.1.3 (entertainment)	1—very low. In Greece there is no published evidence that organized camp sites relate to CES capacity or supply in or nearby the area of the campsite location

Table 1. *Cont.*

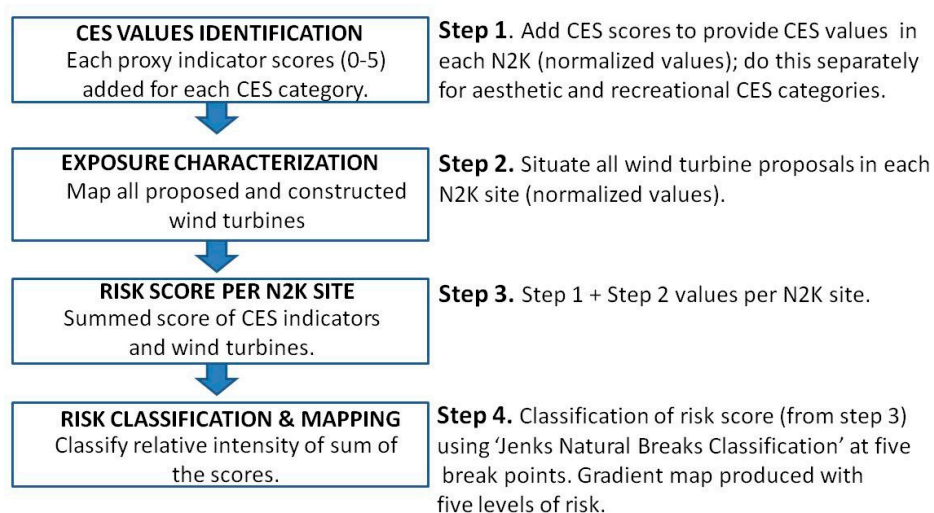| Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	17. Lakes	Presence of large lakes (>200 ha);	Scarce water body type and resource; presence of unique ecosystems of outstanding local and regional values; often they are visually attractive and recreational hotspots. Source: GIS analyses (This study)	3.2.2.1 (existence) 3.1.2.4 (aesthetic) 3.1.1.2 (physical use)	3—medium. These unique and rather scarce water bodies are easy and feasible in mapping (the areal limit to their size is arbitrary); however, they are limited in number and the human–nature interactions vary among them
	18. Mountain Shelters	Special accommodation in mountain huts and refuges created by local and national outdoor recreation interests in outstanding areas of mountaineering interest	Attractiveness of specific mountain areas to outdoor recreation. Source: GIS analyses (This study)	3.2.2.1 (existence)	4—high. These structures occupy an important tradition in mountaineering and outdoor recreation history in Greece. As proxies they are salient, credible and feasible; however their locations/maintenance is notably related to specific services provided by the local environment
4. Aesthetic Values	19. Protected Area Aesthetic Value	As assessed in nationwide survey [62]	Expert based ranking of sites of outstanding aesthetic value. Source: Metadata	3.1.2.4 (aesthetic)	3—medium. This is an expert-based subjective proposal of relative aesthetic value

Table 1. *Cont.*

Category	Indicator	Description	Indicatum (Property Indicated by Indicators) and Data Source for This Survey	CISES (V5.1) Code and Category Equivalent	Certainty Score (Expert Judgment; 1–5) and Comments
	20. Protected Area Landscapes of Outstanding Value	Ranked value of protected areas based on the number of "sites of outstanding natural beauty" are designated within protected area [62]	Areas identified through policy-relevant delineation for protecting outstanding scenic beauty; incomplete application of Law 1469/50. Source: Metadata	3.1.2.4 (aesthetic)	5—ready for use. Feasible, salient and credible since sites are designated. The inventory is not totally completed. This indicator seems credible, legitimate and feasible.
	21. Protected Area Sacred Value	Number of sites designated within protected area as areas with high spiritual values, including ethnographic and folklore values connected to praise of nature [62]	Areas perceived as important for their spiritual values associated with ethnological diversity and various forms of spiritual interest, inspiration and worship. Source: Metadata	3.2.1.2 (sacred/religious)	4—high. The outstanding sites of spiritual value may signal CES supply from landscapes and places of outstanding attractiveness or other cultural values
5. Spiritual and Religious Values	22. Protected Area Religious Value	Number of sites designated within protected areas [62] and updated	Places inspire the building of religious structures (monasteries, shrines, etc.). Source: Metadata	3.2.1.2 (sacred/religious)	3—medium. There are confounding factors that may promote the building of religious shrines, not related to CES supply in protected areas. In some cases, places of worship and monastic complexes do signal CES supply from landscapes of outstanding value

Table 1 presents the 22 initial potential indicators (proxy indicators) selected and defined in this study. We employed Nowak's indicator definition here (Nowak 1977, in Czyż, 2017 [69]), where an indicator signals for the occurrence of another property called

an indicatum. Thus, we describe the indicatum in each proxy and the rationale of selecting the potential indicators. For each potential indicator the matching Common International Classification of Ecosystem Services (CISES) code is also provided.

2.4. Wind Farm Conflict Risk Mapping Exercise

Potential conflict with wind farm development is used here as a case study of risk screening based on the premise that if a large number of wind turbines are developed in a Natura site there is increased risk of reducing CES values. An unprecedented number of wind turbines are planned in Greece, with proposals increasing especially after 2010. The Hellenic government regulatory agency [70] documents that 3045 turbines are already erected (holding operation license), 8215 turbines have been approved through a production license and another 5636 turbines are currently under evaluation. All the wind turbines were mapped in a GIS and we explore the risk of degradation to two CES categories (aesthetic and recreation categories) in relation to the numbers of wind turbines proposed in each Natura site. The simple summation of CES scores and classification of risk mapping is a straightforward process to depict the relative risk of reducing CES values by industrial wind farms (Figure 2).

CES VALUES IDENTIFICATION
Each proxy indicator scores (0-5) added for each CES category.

Step 1. Add CES scores to provide CES values in each N2K (normalized values); do this separately for aesthetic and recreational CES categories.

EXPOSURE CHARACTERIZATION
Map all proposed and constructed wind turbines

Step 2. Situate all wind turbine proposals in each N2K site (normalized values).

RISK SCORE PER N2K SITE
Summed score of CES indicators and wind turbines.

Step 3. Step 1 + Step 2 values per N2K site.

RISK CLASSIFICATION & MAPPING
Classify relative intensity of sum of the scores.

Step 4. Classification of risk score (from step 3) using 'Jenks Natural Breaks Classification' at five break points. Gradient map produced with five levels of risk.

Figure 2. Process of risk classification for wind turbine density per Natura site in relation to CES categories.

As a result, sites are sorted in five prescribed classes per CES category in terms of relative risk: high, serious, moderate, low, no or minimum risk. The definitions follow the application of a gradient of potential risk. This classification is based on a simple numerical taxonomic technique known as the "Jenks optimization method" or "goodness of variance fit" (GVF) [71]. This method is designed to optimize the arrangement of a set of values into so-called natural gradient classes (i.e., the most optimal class range distributed within a data set). This classification seeks to minimize the average deviation from the class while maximizing the deviation from the means of the other groups [72,73]. In the GIS cartographical application we arbitrarily chose five classes to depict a wider spread of relative risk [71] among the hundreds of Natura sites that are assessed.

3. Results

3.1. Mapping the Distribution and Intensity of Proxy Indicators

At the state-wide level, certain proxies of the non-material benefits and services ecosystems may provide to humans were reviewed for the first time. Some of these are concentrated in particular wider areas or regions. A cumulative expression of these data can be provided through heat maps in order to review the distribution patterns (Figure 3). Some of these data are dynamic, i.e., they may change through time as human interest

is discovered or alters through time (bird watching hotspots, rafting courses, designated "Blue Flag" beaches, etc.), while others are static expressions of a particular supply of cultural ecosystem services provided directly by particular ecosystems (e.g., natural spa attractions at thermal springs). To an extent, this state-wide review is influenced by data availability; there is more data for particular proxies, such as outdoor athletic activities and coastal attractions (compare data gap maps below).
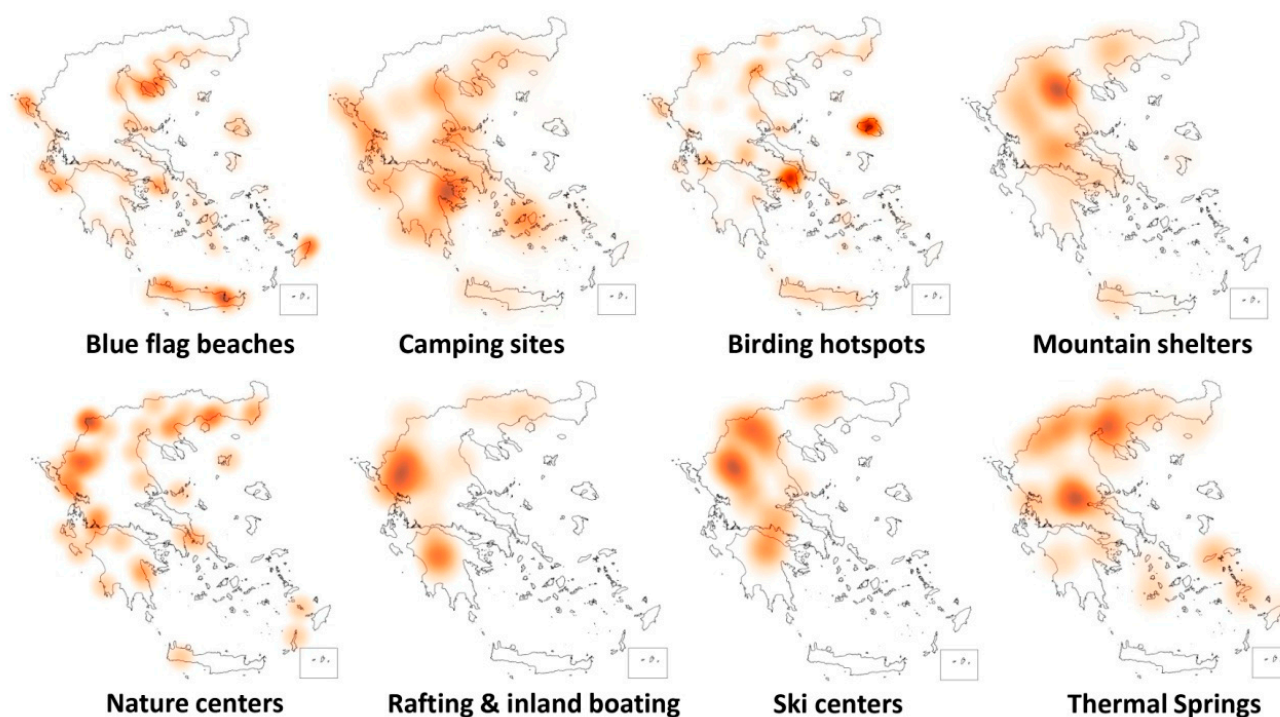
Figure 3. Example of heat maps providing generalization of selected proxy indicators.

3.2. Cumulative Results at the State-Wide Natura 2000 Level

The cumulative depictions of the scores gained from each of the selected proxy indicators provide a CES total "value" for each Natura site. Utilizing five-class boundary classes, we produced gradient maps that showcase the top-scored CES-valued sites (Figure 4A). This prioritization is also expressed using a heat map to identify wider areas of outstanding importance due to a high concentration of CES-valued Natura sites. The heat maps depict highly scored sites (site clusters creating heat areas) that are distributed in close proximity. The heat map approach (Figure 4B) is important for identifying wider areas that concentrate many high-profile Natura sites; these include areas such as Crete (Samaria N.P., Ida Mountain etc.), the northern Peloponnese (Chelmos mountains etc.), eastern-central Greece's mountains (Parnassus, Ghiona, Vardousia, Oiti mountains etc.), the Northern Pindus mountains and the Kalamas river delta and adjacent Kerkyra island, etc. The heat maps depict nearly a dozen such high-ranking wider areas. All of them are of outstanding biodiversity value (and have a high concentration of Natura sites). In contrast, some areas of relative data scarcity and geographic isolation (or distance) from neighboring Natura sites are not highlighted in this assessment (e.g., parts of inland Peloponnese, Boeotia, Thessaly and several islands and islets). Although these relatively isolated sites have relatively less CES significance in this survey, this does not mean they are generally less important in a cultural sense; they are at a distance from clusters of high-ranking sites.
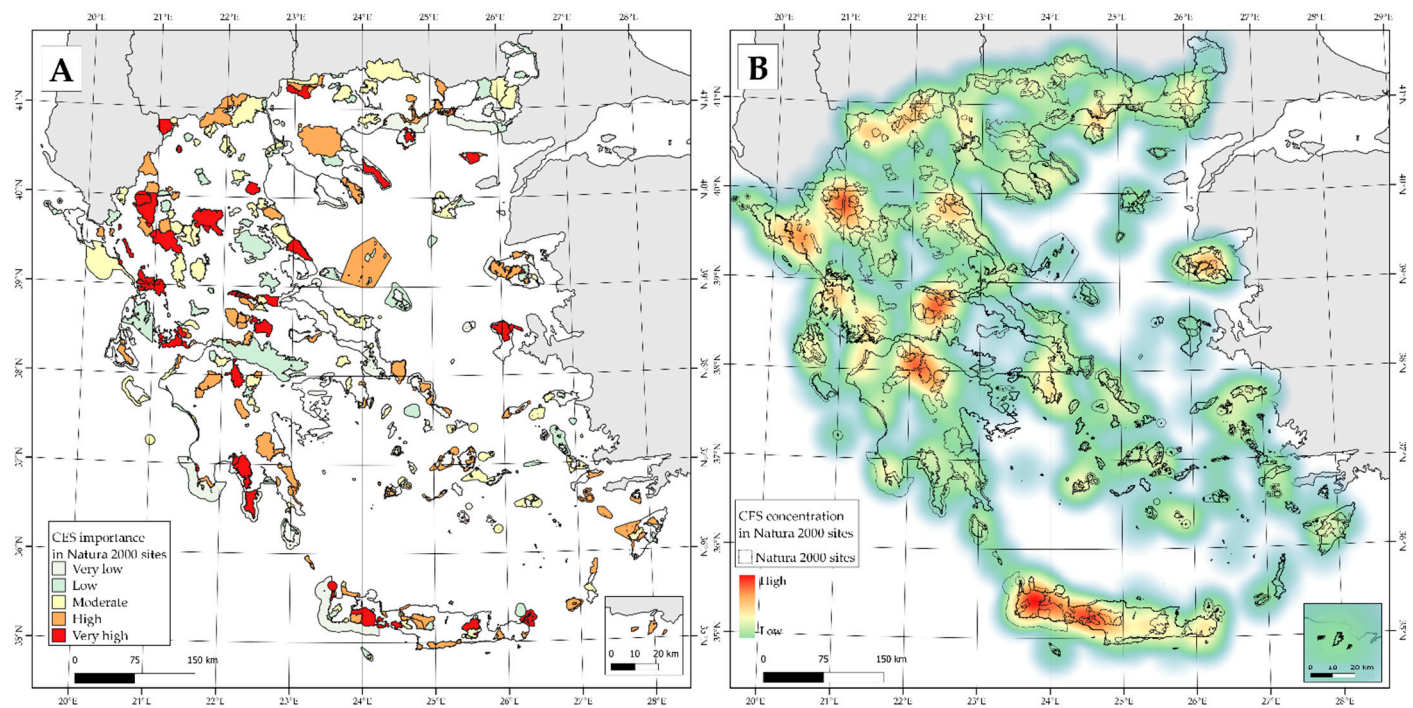
Figure 4. Cumulative CES importance gradient map (**A**) and heat map (**B**) per Natura site, including all five CES indicator categories as developed in the current inventory and assessment. The heat map uses a 40 km radius to define levels of relative concentration of CES highly-valued sites.

3.3. Wind Farm Conflict Risk

The Hellenic government regulatory agency (RAE 2020 [70]) documents that although currently 3045 turbines are already erected, many more are proposed (16,896 in total) (Figure 5A). The actual proposed number and proximity of wind turbines is used as a criterion that derives an initial screening of potentially increasing cumulative effects (i.e., pressures) on landscapes. This is depicted here with a heat map, based on a 15 km radius from each proposed wind turbine. The radius is based on our assumption of the potential visual impact and associated infrastructure change of a typical industrial wind farm, which usually has several wind turbines, with turbine towers usually exceeding 50 m in height. Using this arbitrary radius distance (15 km) of potential influence may also accommodate the visual perception of both wind turbines and associated supportive structures such as new roads, power lines and supportive terminals (Figure 5B).

The number of wind turbines proposed for each Natura site is also depicted in a gradient map solely for each Natura site (Figure 6A). Based on the relative levels of occurrence of all proposed wind farm installations within the terrestrial Natura sites, the levels of concentration at each site are classified using the five-class Jenks optimization method application. This helps showcase where the highest potential conflicts may take place relative to the particular CES values scored at each site. In total, 115 Natura sites where shown to have a high and serious risk of conflict with planned wind farms based on their aesthetic values (Figure 6B). Furthermore, 24 sites fall into high and serious risk based on their outdoor recreation values (Figure 6C). A breakdown of the percentage of all sites is depicted in Figure 7.
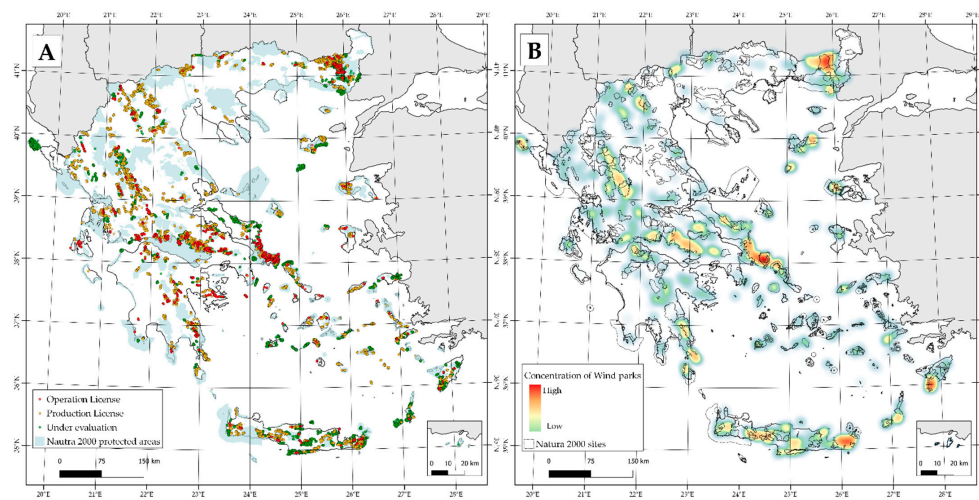
Figure 5. Concentration of wind farms showing the position of constructed wind turbines (with operation and production license) and proposed wind turbines under government evaluation; 16,896 proposed industrial wind turbines are mapped (**A**). The heat map produced by the concentration intensity of wind farms uses a 15 km radius (around each mapped turbine) to define levels of relative wind turbine concentration (**B**). Source: State-wide review from RAE [70], accessed: 29 May 2020.
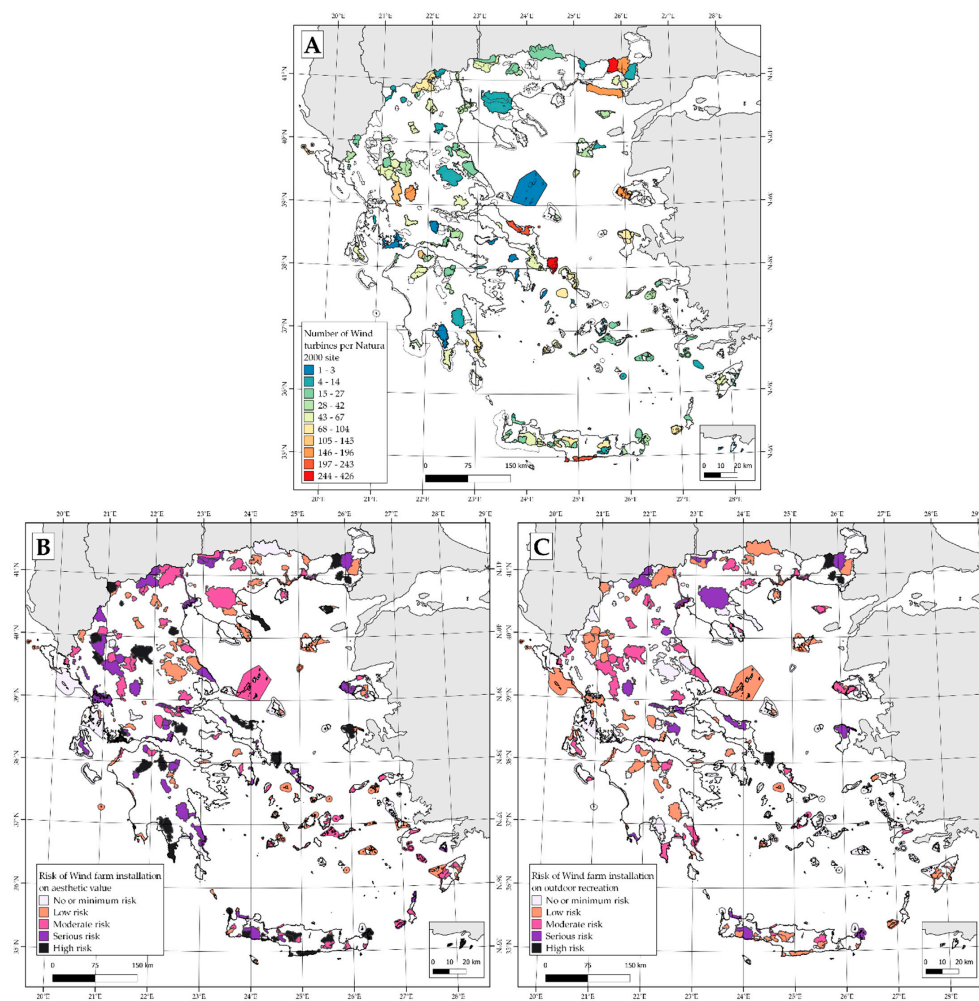
Figure 6. Wind farm risk analysis in Natura sites: total wind farms per site, both operating and proposed (**A**). Potential impact risk map on aesthetic values (**B**) and on outdoor recreation values (**C**). The five-point risk scale follows a simple numerical classification technique (see methods section). Marine-only Natura sites are excluded.
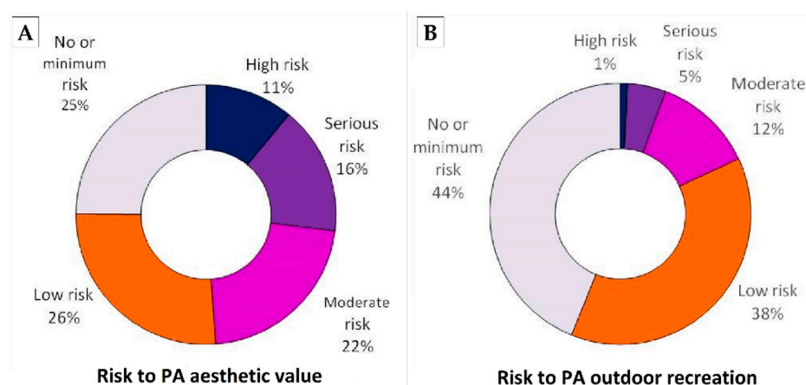
Figure 7. Sites showing the risk of degradation to CES values due to proposed wind turbine developments in Greece's Natura 2000 network. Percentage of sites with potential risk to aesthetic values (**A**) and recreational values (**B**). Specific Natura site conflict risk (color codes) are as mapped in Figure 6 B and 6 C respectively.

3.4. Uncertainties and Data Gaps

One of the major difficulties of testing proxy indicators at this initial stage of a state-wide screening is verifying the certainty and overall usefulness of particular indicators. In our work so far, about half of the proxy indicators seem to satisfy readiness of use with rather high certainty (based on the authors' expert judgment). Nearly half the proxy indicators were registered as having "medium certainty" (Figure 8). Since this enterprise is very important for future progress, we urge further study for validation. One of the obstacles to validation is data scarcity concerning various complementary or equivalent indicators for comparisons and further testing.
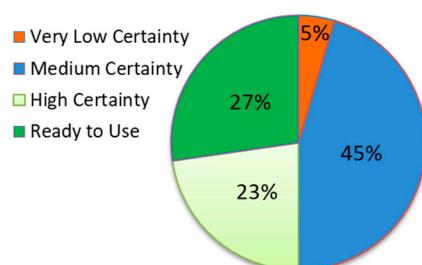
Figure 8. Distribution of 22 proxy indicators used in this study in terms of the level of certainty assessed by the authors' expert judgement (from Table 1).

Greece is a relatively data-scarce country in terms of accessible inventories of various natural and cultural attributes concerning its protected areas. Of course, there are outstanding "honey-pot" locations famous for tourism and biodiversity interest that provide much data and produce repeated references to certain sites [62]. This is apparent when mapping the available data in this review using the European Environment Agency (EEA) 10 × 10 km reference grid. Data availability after the combination of two CES categories shows a concentration in such popular sites and along the coast (Figure 9A). The total data availability of the five CES categories assessed in the study is given (Figure 9B). The cumulative map gives the impression that most of the country is well-covered; but, one should keep in mind the large number of proxy indicators used (22) and the 10 × 10 reference grid that also gives the impression that wider areas are covered. Areas not covered by any available data are rather sparse and predominantly in inland regions.
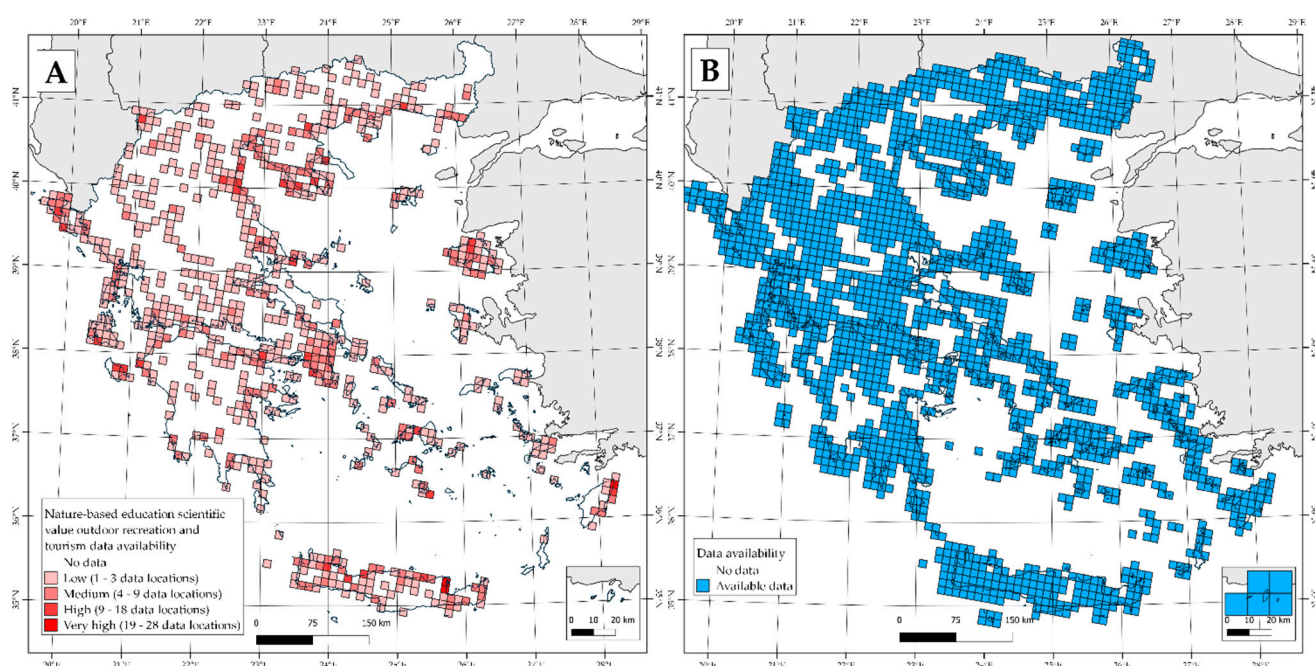
Figure 9. Example of gap analysis using the European Environment Agency (EEA) 10 × 10 km reference grid. (**A**) Data availability after the combination of two categories; i.e., nature-based education and scientific value and outdoor recreation and tourism. (**B**) Total data availability of the five CES categories assessed in the study.

4. Discussion

4.1. Achievements and Context

In Greece, protected areas have never been evaluated for their cultural benefits or the CES they may provide to people. There are few studies with concern for aspects relevant to CES [43,44,62,74,75]. In this rather data-scarce and understudied conservation arena a rapid assessment for CES in Natura sites is an important unmet need.

So far, this rapid survey has provided the following steps for CES application at the protected area network scale in Greece:

- Available data were compiled to build an initial CES database per Natura site, providing an initial inventory. This work is exploratory since only easily accessible proxy indicators were selected as potential indicators; these are meant to be tested and expanded within future research investments. The current fit-for-purpose review follows the methodology and complements Greece's National Mapping and Assessment of Ecosystem Services (MAES) indicators approach [43].
- By focusing on the state's protected area network we can identify priority sites of outstanding CES values or sites "at risk", i.e., an initial screening for prioritization "hot spots". The resulting cartography provides results for a continuing discourse on CES and its utilization in protected area planning and management.
- We explore data and knowledge gaps with respect for the integration of wider conservation management needs (i.e., beyond the strict biodiversity needs) for the Natura 2000 network. This review also contributes by suggesting specific recommendations for future progress in developing knowledge baselines and inventory frameworks for protected areas in general; an important unmet need in Greece (see recommendations, below).
- The wind farm case study initiates a conflict risk mapping exercise. Utilizing CES assessment to identify management problems in protected areas is an important unmet need. Aesthetic and recreational values are important non-material values provided by ecosystems and landscapes in protected areas, yet their effective protection and

enforcement is severely lacking in the Natura 2000 system in Greece. Our cursory screening shows that wind energy development, if continued as planned, will create wholesale changes and severe environmental and cultural degradation in many Natura sites.

The wind farm risk mapping exercise using CES attributes is attempted for the first time at the scale of Greece's Natura 2000 network. This review provides a rapid method to depict overlapping hotspots of selected CES values with proposed wind turbine development pressures. We calculated potential conflict risk in a conservative manner, stacking the selected CES scores with the total number of proposed wind farms within Natura sites. The cumulative number of wind turbines functions as a proxy of modern human-induced change within protected areas. Wind farms of industrial scale are known to have various negative impacts on biodiversity, landscape character and on local communities; notable discourse has developed with concern for such developments in many Mediterranean protected areas [76,77]. Over a decade now, Greek environmental NGOs and researchers have used specific criteria to propose "no-go" areas (exclusion zones) for wind energy development within parts of Natura sites [78]. Public resentment for the apparent damage to ecosystems, cultural values and aesthetic integrity caused by certain wind farm projects is now widespread in Greece. The landscape-scale changes of many new industrial wind farms are widely visible in many former wild land areas in Greece today (e.g., Figure 10).

Figure 10. Examples of visual impacts and associated infrastructure of industrial wind farms that may compromise CES attributes. (**A**) Antia, Euboea Island (38.036548, 24.560521), (**B**) Marmari, Euboea Island (38.094239, 24.309008), (**C**) Kassidiaris, Epirus (39.787521, 20.540946), (**D**) Perganti, Acarnanian mountains-road building (38.784682, 20.998657), (**E**) Perganti, Acarnanian mountains—wind turbines and their platforms (38.769576, 20.992692) (Photograph credits in the acknowledgements).

Our wind farm risk exercise suggests for the first time that in many Natura sites the large number and dense concentration of industrial wind turbines may conflict with certain CES values. Our mechanistic assessment rapidly identifies dozens of Natura sites that face the risk of conflict solely based on the relative number of proposed wind turbines and the high aesthetic and recreational benefits that these sites are known to provide. Since the risk analysis exercise is limited to only two CES categories, this result is in our opinion a bare minimum of the various other negative impacts that may result if all proposed wind turbines are developed. Recent reviews agree that the full ramifications of certain industrial-scale renewable energy developments are poorly studied and social impacts may be high, especially within protected areas and wild land areas [79–81]. Moreover, other similarly widespread resource development problems such as touristic and urban

sprawl, road-building, mining and small hydro-electric plant developments could also be used to explore conflict risk with CES attributes in protected areas, in a similar manner.

Beyond the conflict risk mapping, the approach promoted here follows the MAES procedure, which is now widely used in Europe [64]. The inventory produced (evaluation matrices and maps) is an important part of the reference data platform needed for the implementation of MAES for the Greek territory, and complements recent ES attempts at the state scale [59,82]. Regional-level screening initiatives, such as this rapid assessment, help summarize conditions and/or nature–human interactions that are not directly accessible in other kinds of survey procedures or at finer spatial scales [83]. The framework presented here provides guidance on using proxy indicators to identify areas where conservation actions and conflict risk should be focused. This geographical assessment may help effectively target critical areas for both biodiversity and ecosystem services that directly benefit people. This state-wide assessment exercise also confirms that there are still serious gaps in available cultural resource inventories [62]. Some indicators remain rather ambiguous and poorly defined; this is to be expected in categories such as sacred sites [4] or cultural heritage features in general [84]. There is much more information that can be inventoried and operationalized within a state-wide, site-based framework; for example, concerning tourism and ecotourism, this being another salient and understudied aspect in Greece's Natura sites [74,85]. At a future stage, this inventory and assessment screening could be enhanced with mixed methods approaches, i.e., using different indicator types and different data compilation methods at the regional or site scale [27,86] or the application of qualitative, citizen-based assessments and social media tools [87].

This CES review is timely for Greece, since protected area management is currently undergoing reforms. A new protected area management agency was recently enacted under the auspices of the Ministry of Environment and Energy (Law 4685/2020). Our initial survey work and recommendations (see below), performed at a national scale, could help guide planning decisions, build new management paradigms and perhaps help avoid costly conflicts. Many recent reviews promote the need for science–policy interfaces to address the relationship between cultural values and various land-use decisions [54]. At the state-level survey scale, it has not been easy to bridge the gap among the interfaces of conservation science, policy development and protected area conservation management practices [88,89]. In this context, CES approaches seem to be productive applications for exploratory research and development and conservation planning, even in data-scarce conditions [90].

4.2. Limitations of this Review

Cartography and attempts at quantification are the main steps required in order to improve the recognition and implementation of CES in decision-making and institutional up-take [4,27]. Our rapid survey assesses a large number of varied and rather recently delineated Natura sites. Operationalizing CES indicators in a standard way is difficult at this broad spatial scale and sometimes such reviews are necessarily limited to screening-level generalizations. With this general premise in mind, we recognize the following limitations in this study:

1. Distance-based archival data or metadata previously collected by a single or few reviews may be subject to inherent biases [91], and in data-scarcity conditions bibliographical and online surveys cannot possibly be exhaustive.
2. Natura sites have been differentially studied and biases exist based on their size (areal extent) and exact site-boundary delineations [62]. The larger and high-profile "famous" sites host much more and detailed available data, including cultural attributes and CES values. This situation is difficult to heal: the "smaller" and newer sites (including some peri-urban sites) are less studied and may lag behind in state-wide evaluations due to data gaps or data inventory biases [43].
3. This work focuses mainly on mapping CES supply using proxy indicators, but CES demand is poorly defined here, though it is also important. Exploring social preferences

would be a useful way forward in order to complement this inventory. Tradeoffs and synergies between bundles of services dependent on the ecosystems providing them and on appreciating demand for CES would be important in a revised review [92].

4. Minimal social media data was compiled in this survey; only one citizens' science portal on bird watching/birding hotspots (ebird) [93] was successfully utilized (i.e., accurately identifying locations with outstanding wildlife watching opportunities [94]). Especially since in protected areas local profit-generation depends on tourism, recreation and educational interest [95], involving more actors through social media and crowd-sourcing could enable plural valuation approaches; i.e., assessing multiple values attributed to nature by stakeholders [87,96–98].

5. Marine CES are not investigated in our review for the reasons outlined by Kokkoris and colleagues in 2020 [43]. There are still inherent difficulties and outstanding data gaps in marine areas [99]; and marine protected areas are difficult to compare to terrestrial system conditions in a state-wide scale [100]. We expect specific reviews to develop in this important segment of protected area research soon [87].

6. The distance-based risk mapping on wind farms is not a complete conflict risk analysis. In our opinion, this is a conservative and transparent prioritization screening exercise. This mechanistic representation cannot depict the many and various negative impacts of industrial wind farm developments on wild lands; e.g., where a small number of turbines are placed in inappropriate locations or where off-site wind turbines and their infrastructure may impact adjacent Natura sites. The prioritization exercise focuses on the most vulnerable frontline conflict Natura sites; and it is indicative of the distribution of potential cumulative impacts.

No doubt, as in other CES reviews, conceptual and analytical difficulties are apparent in both this indicator selection and the conflict risk screening exercise. The starting point for choosing interpretation tools is to describe and review CES indicators [9]. We intentionally utilize cartography and spatial analyses that strive for transparency in their method and ease of interpretation, and we intentionally avoid more complex analyses that may misinform or generalize [101]. Finally, prioritizing exercises for protected area sites are not in themselves enough for conservation action [101,102] and it is important to show the basic limitations and where gaps exist. A degree of subjectivity in the selection of available indicators for analysis cannot be avoided, and this is frequently the case in many schemes that produce state-wide spatial protected-area prioritizations [103,104]. According to English and Lee: "The fact of defining intangible values is not itself culturally neutral... but if we do not define intangible values in some way, it will be virtually impossible for them to influence management" [105].

4.3. Recommendations

The inclusion of CES provision within European biodiversity conservation could help enhance present conservation efforts, especially through the development of a greater awareness for cultural values and non-material benefits provided directly to people in and by protected areas [106]. Yet care is needed in using ES surveys where there is data scarcity and poor inventory baselines [84]. Until recently, CES or CES-relevant reviews have been largely ignored or overlooked in planning and policy decision-making [11], but needs and requirements for sustainable protected areas in the EU Natura 2000 network are changing [35,107,108]). A more holistic valuation of protected areas, including the social, socio-economic and socio-political aspects, is now seen as an imperative for successful conservation and sustainability of protected area networks [109].

The cultural and historical idiosyncrasies of each country's protected area network need to be appreciated in order to use CES information effectively in conservation strategies. The protected area network in Greece is evolving and significant reforms should take place. Its evolution has strong socio-political components, sometimes independent of the protected sites' biodiversity management requirements [62,109]. Cultural values and an understanding of CES-relevant issues are thus intimately related to the effectiveness

and sustainability of the protected area network. CES assessments on different spatial scales (state, regional and local) require organized information compilation and integration measures, and a common ES platform should be developed. Beyond the broad-scale survey explored here, contributions are needed directly from the public, stakeholders, experts and policymakers.

Although CES are integrated within the ES framework, they are in many ways more challenging to research, to monitor and apply in practice. Here we propose a multipronged initiative for building CES baselines for Greece's protected areas at the national scale. A state-wide investigation should include the entire network of protected areas and proposed protected areas in Greece, beyond the confines of the Natura sites. Based on current unmet needs, this proposed research initiative should include the following:

- A national inventory of CES and cultural attributes of all protected areas. Information on cultural values and CES within protected areas must be inventoried in a national registry (i.e., all cultural features, including hiking trails and paths, archeological sites and non-material site-based distinctions). Specific investigations should further explore the role of several Natura/protected area site factors, such as the site's size, land cover types and changes, accessibility and other parameters in relation to CES attributes.

- Adaptive CES mixed methods research initiatives. The MAES methodology as well as mixed methods approaches (i.e., both quantitative and qualitative research) should be promoted [43]. Local priorities may dictate the need for indicators specific to single sites or a set of Natura sites (e.g., at the ecoregional or state regional level). It may be useful and important to identify a greater variety of CES types and indicators, and the precise structure of the services and who the beneficiaries are [8,110]. We urge flexibility when developing indicators and other evaluation schemes as has become apparent in recent so-called "post-normal science" applications [111]. A transdisciplinary and adaptive approach should be encouraged [27]. Flexibility in using indicators (including proxy indicators) must be upheld in order to drive exploratory and innovative research at this early stage of CES development in Greece.

- A landscape approach. More attention is needed to landscape-scale research and conservation, especially targeting both highly valued cultural landscapes [3,112] and wilderness (or wild land) areas [81,113]. This ties in with EU policy requirements for high nature value farming [114] and the many modern changes and challenges to European landscapes [79,115,116]. In Greece, particular attention to the conflicts created by industrial wind farm development should be immediately reviewed at the landscape scale. Our broad-scale survey suggests that potential degradation and threats to CES by wind farms in Natura sites may have been overlooked, ignored or even intentionally sidelined within the current renewable energy boom. At the scale of landscapes (sub-areas of the protected area sites) a critical assessment should be developed to explore and respond to the potential threats and risks of degradation to protected area integrity.

- A new emphasis on aesthetic values in protected areas. Aesthetic and scenic values, which are culturally important attributes, may have been overlooked while they have outstanding importance for human wellbeing and are vital components of landscape integrity [117,118]. Specific efforts to explore and document aesthetic values are required at both the protected area site and the wider landscape scale [119–121]. There are many applied approaches to assess and integrate landscape conservation in protected area management [122–124]. Aesthetics is a critical aspect of a CES review, but it is no doubt a "wicked problem" in conservation area management [125]. Compared to other CES attributes, aesthetic indicators may be highly subjective [8] and any attempt towards quantification requires accounting for the uncertainties induced from subjectivity [126]. Despite these difficulties, aesthetics is crucial in landscape planning and conservation, and its involvement in this CES review shows a need for less reductive and more holistic assessment approaches. More particularly

for Greece, all available incentives to preserve the aesthetic quality of protected areas should be promoted; one step is to apply Law 1469/50 to inventory and delineate "Sites of Outstanding Natural Beauty" [53].

- A communication initiative. A strategy for public awareness to promote and effectively enforce protected area conservation initiatives is important. Part of the problem with ineffective conservation outcomes in protected areas is that knowledge about non-material benefits and values is poorly communicated and disseminated. Without investment in publicity and media initiatives for this, the broader socio-ecological issues, especially sensitive and complex ones such as CES, may fall in the back-seat of other conflicting and pressing issues [127,128]. An investment in CES research and its promotion provides a storehouse of the important knowledge needed for conservation-relevant communication, including multi-stakeholder collaboration and participation and education at all levels (including landscape literacy).

The above initiative could help to support some of the growing pains observed in Greece's protected area network. This initiative should support the consideration of cultural and social factors and the productive involvement of various stakeholders and local communities in protected areas. Importantly, this could help direct and promote more efficient involvement in site-scale management, particularly for safeguarding non-material services, such as aesthetic values, that are still much neglected. In fact, the greatest failure of Greece's protected areas may be the lack of concern for spatial conservation planning with respect for the aesthetic and other landscape-scale values.

5. Conclusions

This study provides the first state-wide review of CES in Greece's Natura 2000 network. Such efforts at inventorying and assessing cultural information baselines are important in appreciating protected area attributes for planning at the national scale. This study enabled us to: a) build for the first time a preliminary list of selected CES indicators supplied by Natura sites based on available proxies; b) assess the spatial distribution of the potential CES supplied by these sites; and c) use this information to promote insights for integrated conservation management applications, in terms of a conflict risk assessment exercise. The identification of hot spots and wider areas of significance for the supply of CES could be important for protected area managers, government management agencies and the many stakeholders participating in protected area networks. This procedure may be especially useful in identifying and mitigating conflicts.

Although Natura sites and other natural protected area designations focus on conserving listed species and habitat types, they could also better help protect unique cultural attributes and the protected areas' cultural and societal values in a holistic way. Mediterranean protected areas are special social constructs and should not be viewed solely as strict preserves for nature. The results of this study may help promote interest in CES, to urgently conduct more in-depth inventories and produce assessments at varying scales using adaptive mixed methods through an integrative research platform. Protected areas demand new multidisciplinary, transdisciplinary and inclusive approaches in order to guide management and to protect ecosystems and landscapes from inappropriate developments. Interest in CES also helps promote protected areas' sustainability as "protected area institutions" that uphold many inherent cultural values. Protected areas are natural laboratories for implementing various types of CES assessments, and the rapid screening procedure utilized here should be applicable in other countries and protected area jurisdictions as well.

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