

Can the Integration of Environmental Dimension Make Smart a Metropolitan Context? An Argument about Planning in the Recently Established Metropolitan City of Cagliari and Natura 2000 Network

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1 ABSTRACT

In accordance with Article 3 of the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive), Natura 2000 is a coherent Ecological Network (EN), distributed throughout the European Union, that includes Sites of Community Importance (SCIs) and Special Areas of Conservation¹ (SACs), mentioned in the Habitats Directive, and Special Protection Areas (SPAs), mentioned in the Directive 79/409/EEC of 2 April 1979 (Birds Directive, modified by the Directive 2009/147/EC on the conservation of wild birds).

In the context of scenarios based on ecosystem relationships, the strategic concept of EN can mitigate biological issues on natural components related to the high pressure of human activities. These activities generate impacts and fragmentations in the matrix of ecosystems.

Environmental fragmentation and connectivity of ecosystems are crucial points for implementing sustainability concepts in territorial government processes. For a good governance and to make the necessary correction in environmental management, the achievement of urban and regional quality, compared with this issues, is essential. Planning in ecological connectivity needs an appropriate conceptual EN model about the Natura 2000 Network, in order to reason about elements defined in Article 10 of the Habitats Directive.

In the last years, in Europe, the phenomenon of metropolitan growth is rising and the issue of government in metropolitan contexts assumes considerable importance. Indeed, most of the EU inhabitants live currently in metropolitan areas, where they generate more than two thirds of the Gross Domestic Product (GDP) of Europe. The European Commission, in order to the Cohesion Policy 2014-2020, urges Member States to adopt an urban agenda regarding several features (e.g. limitation of land use, urban regeneration, transport infrastructure and sustainable mobility). These aspects can help to making cities smarter integrating environmental dimension. Indeed, this work is based on the recent debate concerning Italian metropolitan cities, focusing on the environmental context of the Natura 2000 Network related to one of the most populated areas of Sardinia: the Metropolitan City of Cagliari, recently established. Many sites of the Natura 2000 Network are included in this metropolitan area and they are ruled by management plans.

In the current debate on approaches to metropolitan planning, we discuss the implementation of the Natura 2000 Network into public policy and governance, in order to achieve smart practices in planning. These approaches are decisive to set up an evaluative knowledge taking into account the eco-environmental sphere represented by the EN.

For this purpose, we propose a qualitative approach based on habitat suitability of a specific species in order to interpret its possible movements through the metropolitan area. Habitat suitability models allow to put in evidence relationships between species and environment; this constitutes an important initial basis to assess potential distribution of each species in the metropolitan area. This issue can relate to the Natura 2000 Network management, both as nodal and as connective elements, in planning in metropolitan contexts.

In our opinion, the Strategic Environmental Assessment (SEA) is a fundamental process for integrating environmental considerations into plans and programs and it allows to formulate objectives and to support monitoring of plans. We believe “environmental smart” could be meaning the implementing of this ecological concepts into public policy and governance, based on the sustainability theory. Our position is that to becoming smarter, the Metropolitan City of Cagliari should become more environmentally sustainable and aware of its environmental heritage.

¹ SACs are sites established by Member States through a statutory, administrative and/or contractual act.

2 INTRODUCTION

In accordance with McHarg (2007, p. 202), making plans into metropolitan areas has to understand natural processes, hence, we have to learn to “design with nature”.

From a smart environmental perspective, we cannot avoid the environmental context on which planning should be based, because the increasing fragmentation of habitats is a consequence of human activities. One of the most critical point on the habitat fragmentation is the land connectivity reduction for species (Pereira et al., 2011; Ferretti et al., 2013). Therefore, subjects concerning EN should be annexed in planning processes, but, at present, they are lacking. To address existing lack at all levels of spatial planning, several studies (e.g. Cullotta et al., 2011) emphasize the importance of integrating multi-disciplinary aspects in planning in the field of EN.

The SEA is a fundamental process that allows the integration of these aspects. Indeed, according to the European Directive 2001/42/EC, if plans and programmes have an impact on the environment, the strategic environment assessment is required. This assessment involves the systematic identification and subsequent evaluation of environmental impacts of strategic actions and it considers social, environmental and economic effects of plans or programmes.

This work aims to propose an analytical approach to integrate the Plan of the Metropolitan City of Cagliari and habitat suitability models, during the drafting of the SEA, taking into account an environmental relationship between land spatial elements and the perception of a species (or groups of species). We discuss, in particular, both about the current situation of the Natura 2000 Network, and about how general ecological aspects can be integrated into spatial planning.

The paper structure is organised as follows.

In section 3, we discuss some general concepts about EN, to introduce the Natura 2000 Network and describe some aspects of sites management. In section 4, we describe the Natura 2000 Network in the Metropolitan City of Cagliari. Initially, we draw attention to some aspects about the metropolitan governance; then, we provide an analysis of the metropolitan context with reference to the Natura 2000 Sites. In section 5, we propose a qualitative approach based on habitat suitability, using data available in literature which concerns only the inner part of the sites of the Regione Autonoma della Sardegna (RAS) [Autonomous Region of Sardinia]. The purpose of our approach is to extend existing data throughout the Metropolitan City of Cagliari. Hence, we select a species that, in addition to the availability of data, is also representative of a critical situation for its preservation. Finally, after discussing data and results obtained, we draw attention to the connectivity for species dissemination and conservation with a potential ecological corridor in the metropolitan area, emphasizing problems associated with wide-area planning in reference to the Natura 2000 Network. In sections 6 and 7, we discuss some issues to integrate this environmental dimension in metropolitan planning into the SEA. Our proposal concerns integrating an analytical approach, based on habitat suitability, inside the SEA process, in order to planning and formulating strategic objectives for a sustainable development, enabling the materialization of an EN within the metropolitan context.

In our opinion, the integration of this environmental dimension about ecological aspects make the metropolitan context smart.

3 ECOLOGICAL NETWORKS

3.1 General concepts about ecological networks

In scenarios based on ecosystem relationships, the strategic concept of EN allows to minimize ecological problems related to high pressure due to human activities on natural components. These activities, like use of unsuitable agricultural and forestry practices, pollution, spread of exotic species, infrastructure construction and urbanization, have significant impact on the environment and cause changes and fragmentation of the ecosystems matrix. EN should be a role model for conservation, protection and management of biodiversity within processes of land use government, through a systemic approach in planning decision making processes (D'Ambrogi et al., 2013).

In landscape ecology, the movement of the species in the EN is ensured through important elements for wild fauna and flora, and mentioned as ecological corridors, but, about this matter, we need to distinguish the concept of “connectedness”, from the more complex concept of “connectivity” (Baudry et al., 1988).

The first concept regards the physical contiguity between kinds of ecosystems and/or populations. The second concept takes two components into account: the first is a structural element and it depends on the spatial position of ecosystems, on their physical continuity, on the presence, type and size of natural or anthropic elements; the second is a functional element and it regards the species perception scale, and their ecological and behavioural requirements, including their degree of specialization. Therefore, there is a substantial difference between physical and territorial aspects, and ecological and functional aspects about the concept of spatial “restituting” relatively of wild species mobility (Battisti, 2004; D’Ambrogi et al., 2015).

3.2 The Natura 2000 Network

Natura 2000 is a coherent EN, established in accordance with Article 3 of the Habitats Directive in order to protect biodiversity, to conserve wild flora and fauna species, and natural habitats existing within the Member States, taking economic, social, and cultural requirements into account, as well as regional and local characteristics. This EN includes SCIs and SACs, designated under the Habitats Directive, and SPAs, designated under the Birds Directive.

In relation to habitats and species, the ecological coherence should be a function not closely bound up with individual sites, but also with their overall interrelation with the entire network. In this context, the concept of ecological corridors plays an essential role.

In the Decree of the President of Italian Republic (DPR) no. 357 of 8 September 1997, Article 2, paragraph 1, letter p, there is a first definition of connective elements, about ecological corridors, as “aree di collegamento ecologico funzionale [functional ecological linking areas]”, in relation to Article 10 of the Habitats Directive. Consequently, in order to improve the ecological coherence of the Natura 2000 Network, a smarter spatial planning should integrate elements that are of major importance for wild fauna and flora, which may be construed as connective elements essential for migration, geographical distribution, and genetic exchange of wild species. Therefore, planning in the context of EN assumes a crucial importance with particular regard to priority natural habitat types and priority species.

3.2.1 The sites and their management

In accordance with the principle of environment integration into other Community policies, to contribute to the coherence of the Natura 2000 Network, the Habitats Directive, in Article 6, paragraph 1, introduces the management plans as “specifically designed for the sites or integrated into other development plans”. In Italy, this issues are transposed by the DPR 357/1997, and subsequent amendments, where conservation measures may involve, when necessary, appropriate management plans, in order to regulate activities and to maintain sites in a good state of conservation, and to establish protection rules. The Ministerial Decree of 3 September 2002 introduces national guidelines for the management of the Natura 2000 Sites; these management plans are not always necessary, but, when they are drafted, they should take the peculiarities of sites and all planned activities into account. However, drawing up a management plan is important, inasmuch conventional spatial planning seldom ensures the integration of environmental objectives in planning practices.

In Sardinia, management plans for all sites of the Natura 2000 Network are compulsory, according to regional guidelines for drawing up management plans of SCIs and SPAs. Moreover, regional guidelines describe when the process of management plan has to be accompanied by SEA, and instead when the process of management plan has to be submitted to screening.

4 THE NATURA 2000 NETWORK WITHIN THE METROPOLITAN CITY OF CAGLIARI

In Sardinia, the Natura 2000 Network consists of 31 SPAs, 87 SCIs and 6 SCIs/SPAs; no SCI has become SAC yet.

In this work, the proposed reflection lays the foundation in the recent regulatory fervour regarding metropolitan cities, reasoning about one of the most populated areas in Sardinia: Cagliari and its extended hinterland.

The Metropolitan City of Cagliari, recently established, consists of 17 municipalities where 16 sites of the Natura 2000 Network are included (12 SCIs and 4 SPAs, see Fig. 1 and Table 1). As such, this new authority

should adopt a new spatial plan able to address on smart management the metropolitan area and, in this context, the role of the SEA will be essential.

4.1 Some aspects about the metropolitan governance

Metropolitan cities are local authorities acknowledged by the Italian Constitution. The Italian Law no. 56 of 7 April 2014 attributes to metropolitan cities the same functions of provincial administrations. In addition, other functions are the adoption and the annual update of a three-year metropolitan strategic plan, and general spatial planning.

In Sardinia, the Regional Law no. 2 of 4 February 2016 establishes the Metropolitan City of Cagliari as local authority. According to the Regional Law no. 9 of 8 September 2006, functions of provincial administrations (consequently now also of the Metropolitan City of Cagliari) are the protection and the enhancement of natural environment, and the protection of flora and fauna.

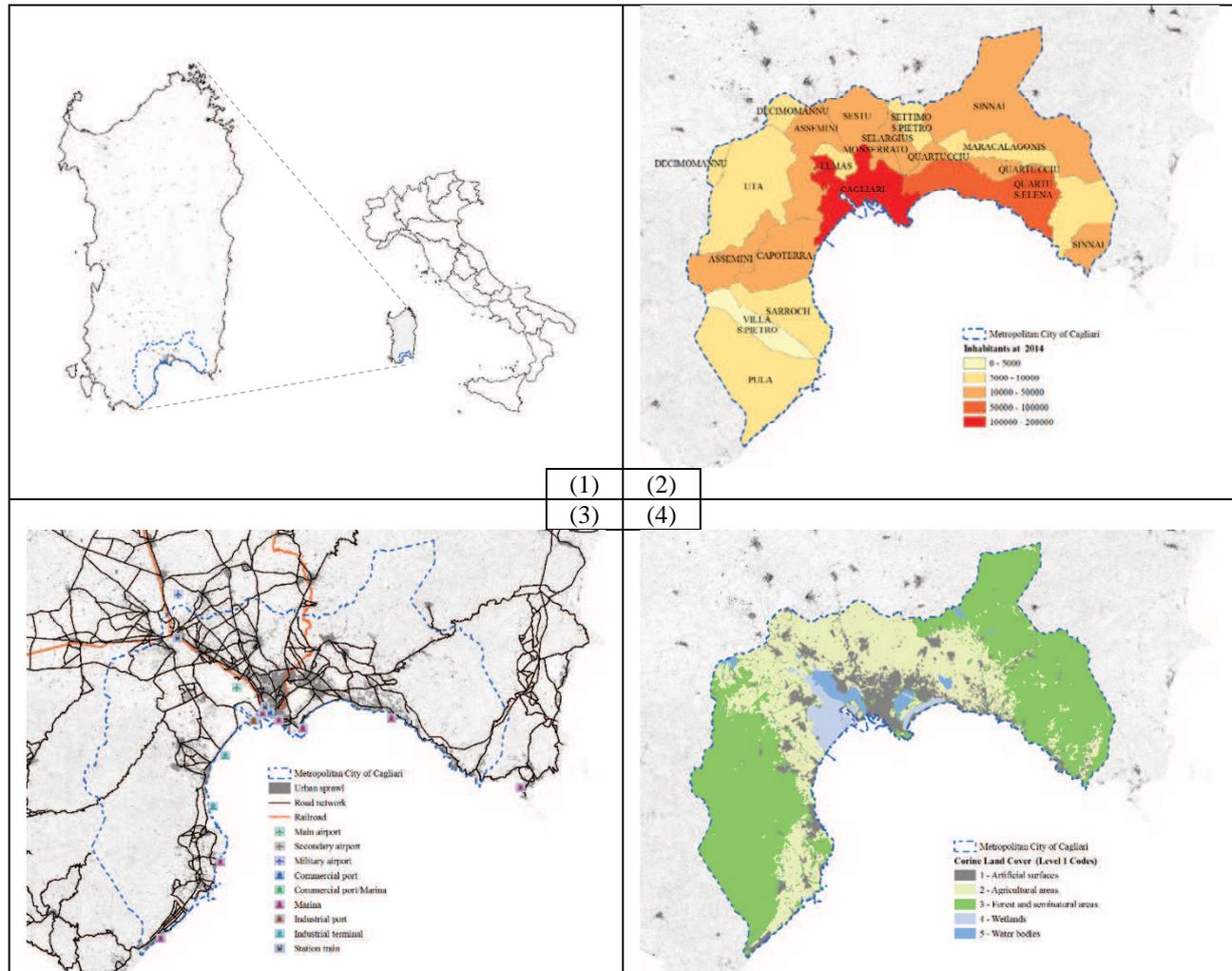


Fig. 1: the metropolitan context of Cagliari. In (1), the geographical information; in (2), the 17 municipalities classified by population; in (3), the main transport network; in (4), the land use based on level 1 Corine Land Cover. Source: authors' elaborations.

4.2 Context analysis of the study area

The Metropolitan City of Cagliari is located on the southern coast of Sardinia and includes: Assemini, Cagliari, Capoterra, Elmas, Monserrato, Quartu Sant'Elena, Quartucciu, Selargius, Sestu, Decimomannu, Maracalagonis, Pula, Sarroch, Settimo San Pietro, Sinnai, Villa San Pietro, Uta. The population is approximately 430,000 inhabitants, and Cagliari and Quartu Sant'Elena are the municipalities with the highest number of inhabitants. The total area amounts to 1,247 km², about the 5% of the surface area of Sardinia. In the metropolitan context there are some of the most important strategic transport poles for Sardinia's Island, such as ports (Marina, commercial and industrial port) and airports (the main, the secondary and the military airport), as shown in Fig. 1, panel 3.

	7	ITB042207	Canale su Longuvresu	
	8	ITB042216	Capo di Pula	Approved
	9	ITB042231	Tra Forte Village e Perla Marina	
	10	ITB042241	Riu S. Barzolu	Approved
	11	ITB042242	Torre del Poetto	Approved
	12	ITB042243	Monte Sant'Elia, Cala Mosca e Cala Fighera	
	13	ITB043055	Monte dei Sette Fratelli	In approving (with SEA)
SPA	14	ITB044002	Saline di Molentargius	-
	15	ITB044003	Stagno di Cagliari	-
	16	ITB044009	Foresta di Monte Arcosu	In approving (with SEA)

Table 1: The sites of the Natura 2000 Network in the Metropolitan City of Cagliari.

Only two of the four SPAs are not endowed with a management plan (ITB044002, ITB044003), while the other two SPAs are endowed with a management plan and with SEA process (ITB043055, ITB044009). Each SCIs is endowed with a management plan, but in two cases a single management plan is established for multiple sites: one is the case of ITB042242 and ITB042243 sites, which are completely contained in the Municipality of Cagliari; and the other one is the case of ITB042207, ITB042216, and ITB042231 sites, which are completely contained in the Municipality of Pula. No SCI management plan possesses a SEA process.

In the Natura 2000 Sites, into the metropolitan context, there are 90 species of Community interest: 3 amphibians, 63 birds, 3 fishes, 2 invertebrates, 9 mammals (one of which is a priority species: *Cervus elaphus corsicanus*), 6 reptiles (one of which is a priority species: *Caretta caretta*) and 4 plants (one of which is a priority species: *Carex panormitana*).

5 A QUALITATIVE APPROACH FOR HABITAT SUITABILITY ASSESSMENT FOR A SPECIFIC SPECIES

The followed methodology to analyse the metropolitan context of Cagliari is based on a dual approach linked to territorial and ecological aspects. Maintaining a physical and territorial, and an ecological and functional continuity within natural environment is an eligible strategy to be considered during the planning processes, which would mitigate fragmentation effects in favour of a better ecological connectivity (Battisti, 2004).

The particularity of this dual approach is developing a habitat suitability map, based on suitability species-specific values and on land uses, with literature data. In this way, it is possible to investigate both suitable elements for species displacements, and elements that simultaneously constitute resistance to the movement. This resistance could be described as effect of physical characteristics preventing rate of flow of species, energy, and material (Forman, 1995, p. 279; EEA, 2014). For a specific species, resistance values could be simply selected by similarity of elements to suitable habitats; consequently, a study area could be subdivided into more-suitable and less-suitable like habitats, so less-suitable elements could be represented as major resistance (Forman, 1995, p. 279). These maps, processed for the whole metropolitan area, allow to locate potential movements of a species: from one side, a physical sense given by land use meanings; from the other side, a perceptive scale of species examined in the context.

A similar approach is suggested in several studies (Massa, 2001; Boitani et al., 2002; Marull et al., 2005), and in our work it is qualitatively applied to the context of the Metropolitan City of Cagliari.

5.1 Description of materials and input data

Used data in the applied methodology to this study are based on two conceptual types:

- spatial data that describe environmental variables, such as land use classes of level 3 and infrastructure networks data;
- spatial perception data on species compared to a particular land use, such as suitability of fauna species-specific values.

5.1.1 The land use maps

A land use map³ was built by the RAS in 2008, in 1:25,000 scale, on the Roma40-GaussBoaga West-zone reference system. The map is a geographical database of the land cover of Sardinia; the legend, adapted to the local situation, respects the standard coding and the classification methodology of CLC entities. Database contains both areal and linear elements. Areal elements are related to land use classes and their classification is until level 5. Linear elements represent: potential hydrographic network with canals and waterways, and rivers, streams and ditches; transport infrastructures with railway network and allowed space, and road networks and ancillary spaces.

In our study, as baseline reference for physical analysis of the land suitability, we assume the level 3 CLC.

5.1.2 The monitoring system

Since 2010, a monitoring system of conservation status of habitats and species of Community interest has been implemented by the RAS (RAS, 2010). Among the attachments of this report, there are several elaborations about fauna suitability maps and values, in 1:10,000 scale. These maps are built only for the space included into the Natura 2000 Sites boundaries. For each land use class (specifically for level 3 CLC) species-specific values of habitat suitability have been associated. These values have been derived directly from the “Rete Ecologica Nazionale [National Ecological Network]” (REN, see Boitani et al., 2002).

The REN is a similar approach taken at Italian level for the protection of several fauna species. Despite this, the list of fauna species, analysed in the REN, does not include all species listed in the Habitats Directive and contained in standard data forms. Consequently, in Sardinia habitat suitability values are identified, over land use, but not for all species.

The suitability values available in these cartographic products are organised as follows:

- 0 (not suitable): spatial elements that do not meet the ecological requirements of species;
- 1 (low suitability): spatial elements that can support presence of species, but not stably over time;
- 2 (average suitability): spatial elements that can support stable presence of species, but that are not optimal places;
- 3 (high suitability): spatial elements that are optimal places for permanent presence of species.

As baseline for our analysis, we assume these fauna suitability maps in order to effectively identify potentially suitable areas to host fauna species of Community interest, not just within the Natura 2000 sites, but also within the entire metropolitan area. In our view, these assumptions are useful for a smarter management and planning of the metropolitan area in a perspective of eco-environmental dimension.

5.2 The selection of the species for analysis

5.2.1 The species chosen: Euleptes Europaea

The Euleptes Europaea (previous scientific name was Phyllodactylus Europaeus and in Italian is known as Tarantolino) is a reptile and is an endemic species of the west-central Mediterranean. The species prefers coastal areas and lives especially in large Mediterranean islands, as Corsica (France) and Sardinia (Italy). Its habitat and ecology preferred are arid and rocky areas, such as cliffs, boulders and stone walls in agricultural land and it can be relatively abundant within suitable habitat. This species may be encountered in abandoned houses, but it largely avoids areas of maquis vegetation, woodland and urban areas. Euleptes Europaea is a nocturnal species and its diet is constituted by insects, spiders and vegetables. Particularly, in Sardinia this species⁴ is locally threatened by habitat loss resulting from fires, picking recreational purposes and urbanization (Corti et al., 2009).

The Euleptes Europaea is mentioned in the standard data forms of seven Natura 2000 Sites within the Metropolitan City of Cagliari: ITB040021, ITB041106, ITB042216, ITB042241, ITB042242, ITB042243, ITB043055.

³ The last updated land use map, referring to 2008, can be downloaded from the RAS website by interoperability services on GIS: WFS services for vector data of SITR-IDT available at:

[http://webgis.regione.sardegna.it/geoserver/ows?service=WFS&request=GetCapabilities, version: 1.1.0.](http://webgis.regione.sardegna.it/geoserver/ows?service=WFS&request=GetCapabilities, version: 1.1.0)

⁴ Other information is available at: [http://www.sardegnaambiente.it/j/v/159?c=1582&s=9024&t=1&v=2.](http://www.sardegnaambiente.it/j/v/159?c=1582&s=9024&t=1&v=2)

5.2.2 The grounds for selecting the species

In this study, the species selection is conditioned by the availability of data and information. Indeed, as mentioned earlier, suitability values, derived from the REN, do not concern all species of the Habitats Directive and, therefore, not all species existing in Sardinia can be studied with an approach based on habitat suitability values compared to land use. In particular, the choice is based on the assessments contained in the “Quadro di Azioni Prioritarie per la Rete Natura 2000 della Regione Sardegna – Periodo di programmazione 2014-2020 [Prioritised Action Framework for the Natura 2000 Network of the Sardinia region, programming 2014-2020]” (RAS, 2014, p. 41), where the conservation state of some species is evaluated, in accordance with Article 17 of the Habitats Directive, for the whole region.

This assessment sets species according to the following definitions, agreed at the Community level:

- Conservation status “FV – Favorevole [Favourable]”: species able to thrive without any change of management and strategies currently in place.
- Conservation status “U1 – Sfavorevole/inadeguato [Unfavourable/inadequate]”: species that require a change of management policies, but not endangered.
- Conservation status “U2 – Sfavorevole/cattivo [Unfavourable/bad]”: species in serious danger of extinction (at least locally).
- Conservation status “XX – Sconosciuto [Unknown]”: inadequate information to make a judgment.

Table 2 shows the evaluation of the conservation status of the *Euleptes Europaea* species. The choice of this species depends on whether it is in a state not overly critic, which allows to mitigate situation by taking appropriate measures.

Species	Range	Population	Habitat	Future Prospects	Overall Assessment
<i>Euleptes Europaea</i>	FV	U1	U2	U2	U2

Table 2: The assessment of the conservation status of the *Euleptes Europaea*. Source: RAS (2014).

5.3 The Habitat suitability approach

Habitat suitability models allow to integrate relationships between species and environment and, therefore, they represent a powerful tool for supporting hearings and projects relating to conservation and regional planning. A habitat suitability assessment constitutes an important initial basis to plot potential distribution of every single species in the area (Boitani, 2002, p. 34).

Using data and materials, as described above, we process the habitat suitability map, as shown in Fig. 3, for the *Euleptes Europaea* species in the context of the Metropolitan City of Cagliari.

Regarding Fig. 3, panel (1) represents the habitat suitability map, specifying: in red areas with zero value; in yellow areas with low suitability; and in green areas with average suitability; while there are no level 3 areas with high suitability, because level 2 is the highest suitability for this species in this study. Panel (2) highlights sites where the *Euleptes Europaea* presence is detected (according to data extracted from the standard data forms transmitted to the European Community on 2015). Panel (3) highlights all 16 sites that interest the metropolitan area. Panel (4) indicates, in green dashed line, a potential species-specific “ecological corridor”, which is an ideal path that the test species could take during a hypothetical movement from East (areas where it is listed) to West (areas where there are a lot of values equal to 2).

However, it is important to highlight that the species behaviour depending on the scale of its perception, its mobility and ecological profile. Consequently, functional connectivity is species-specific and there are no “universal corridors” to support all movement through fragmented habitats or an exclusive valid scale to study ecological connectivity (Gurrutxaga et al., 2010).

5.4 Issues associated with the spatial planning and the Natura 2000 Network

Reduction and fragmentation of natural habitats are considered one of the main reasons of critical issues involving biodiversity, as a result of intensive farming practices, excessive urbanisation and infrastructure networks. Into the ecological field, the spatial planning plays an important role in conservation policies and strategies, recognising the need to integrate issues related to the eco-environmental dimension (Ferretti et al., 2013).

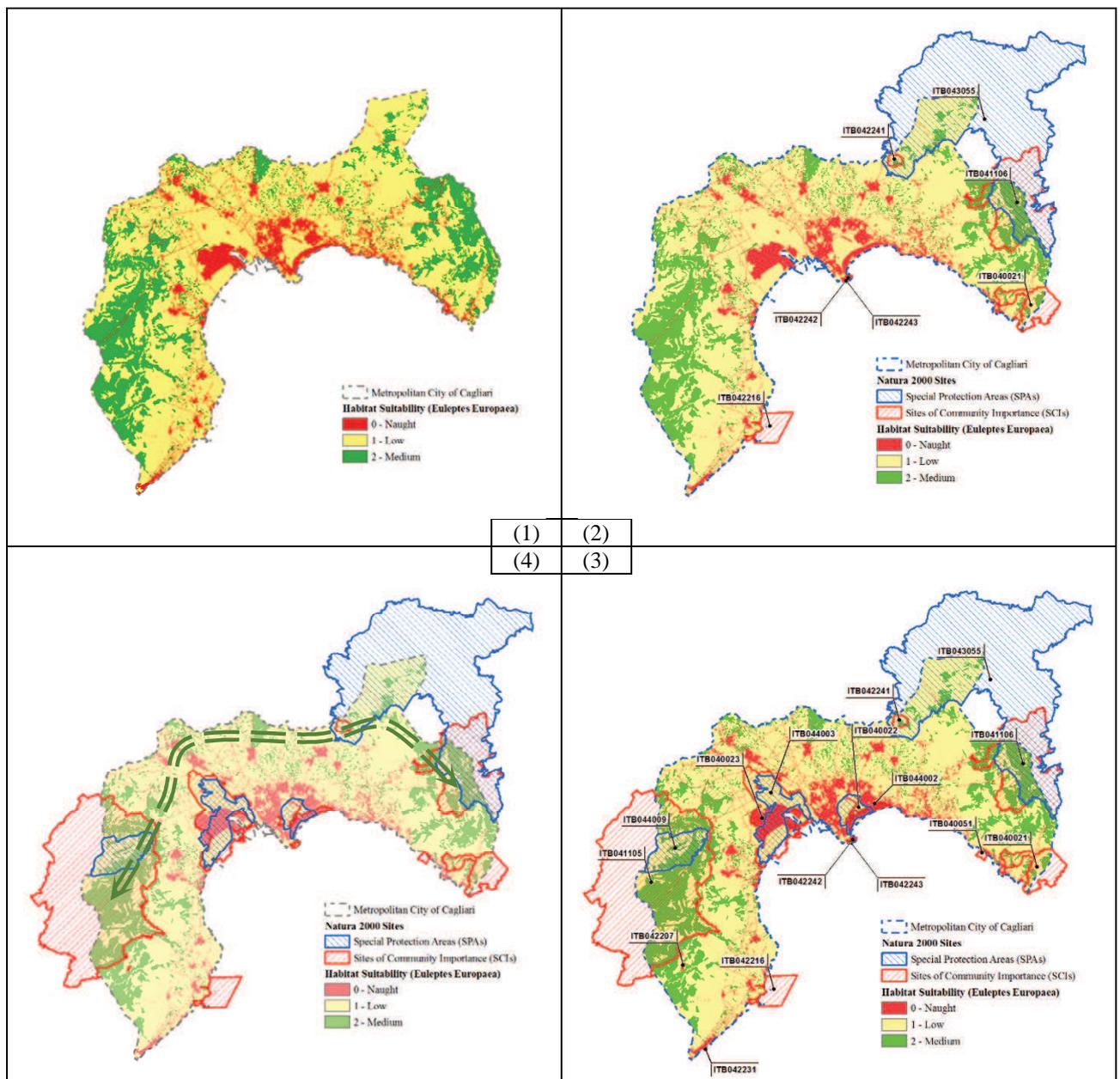


Fig. 3: Habitat suitability maps of the *Euleptes Europaea* in the metropolitan context of Cagliari. Source: authors' elaborations.

The Metropolitan City of Cagliari shows the highest population density in the central area and along the coast. From an ecological and functional point of view, physical elements, in particular such as main road infrastructures in central sector, seem to be an almost insurmountable obstacle between East and West (Fig. 4). In the “Rapporto ambientale del Piano Urbanistico Provinciale/Piano Territoriale di Coordinamento della Provincia di Cagliari [Environmental Report of the Master Plan of the Province of Cagliari]”, a critical issue, already reported, is that a provincial emergency is attributable to the wetland system (located in middle position, as shown in Fig. 1, panel 4) in the area of Cagliari (Provincia di Cagliari, 2011); in fact, from an environmental point of view, this area is threatened by urban and industrial pressure. These factors influence quality and ecological functions due to the settlement growth, compromising opportunities of relationship with inland environmental systems.

The implementation of ENs, through identification of connective elements, into environmental policy-making should mitigate the critical aspect shown in Fig. 4. Western sites, where the *Euleptes Europaea* species is not listed among the species present in standard data form, have a potential suitability according to the highest value. Therefore, at planning level it is necessary to take possible movements of the species into account within the metropolitan area, anticipating critical issues that the plans could generate.

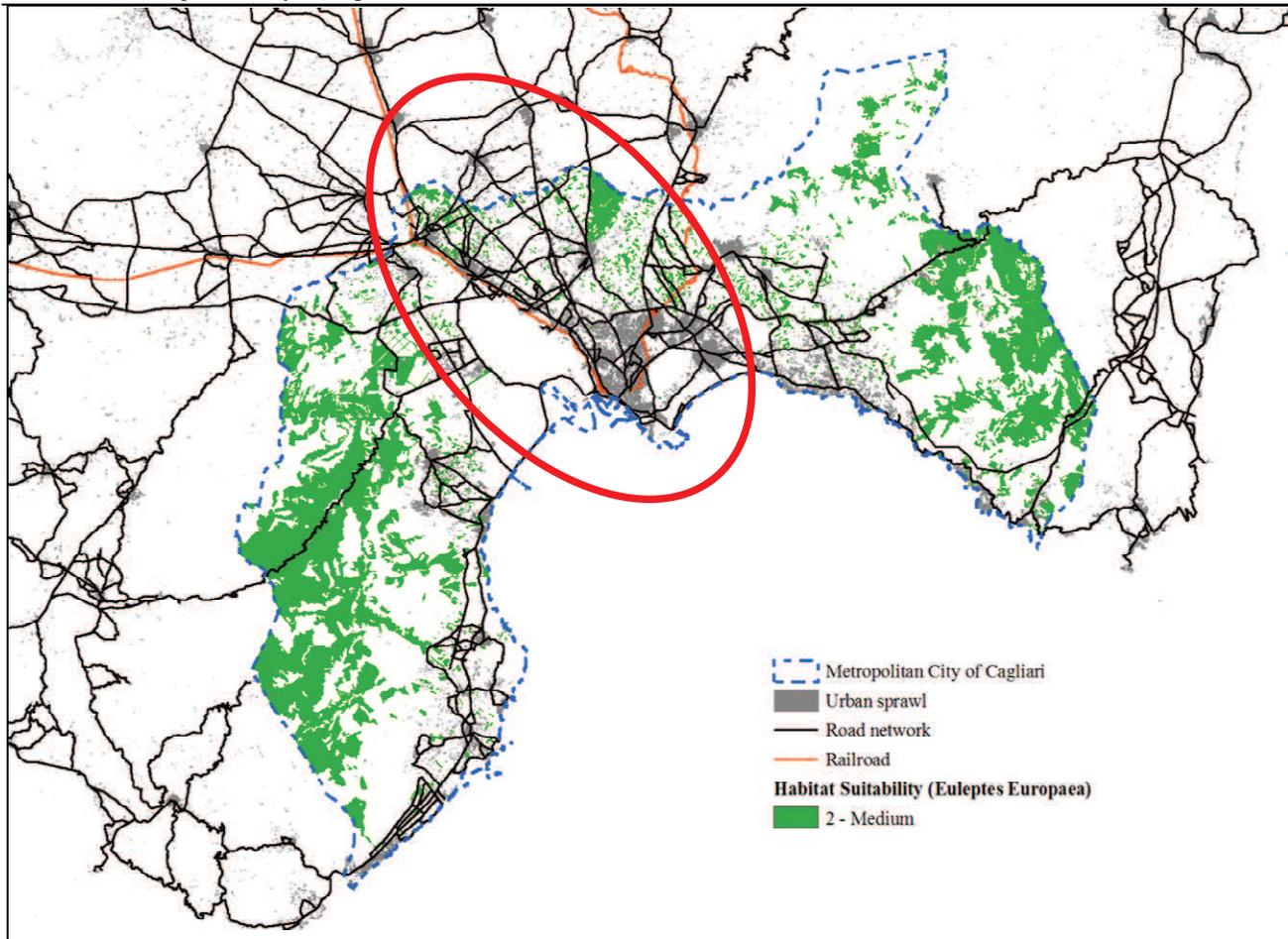


Fig. 4: Bordered in red, the main critical area for the *Euleptes Europaea* in the metropolitan context of Cagliari. Source: authors' elaborations.

Furthermore, the management plans of the Natura 2000 Sites, included in the metropolitan area, are specific for each sites and they do not relate with the other management plans of sites nearby. Moreover, they do not assess external elements that can mitigate this critical situation, and they do not address the concept that species can migrate from one to another site. Not even in the only two cases of the SEA process of SPAs Management Plan, these critical issues are addressed or mitigated.

In fact, an EN implemented into a large area may not be the only integration of all species-specific networks, but it should be a comprehensive assessment of the whole context, based on the knowledge of ecological functionality. In this way, it is possible to build a network model, regarding functions of species in relation to dynamic, structural, and ecological characteristics (MATTM, 2009, p. 8).

In our study, the analysis related to examined species has identified obvious weaknesses. These weaknesses need to be addressed in completing the configuration of network and, at metropolitan level, spatial planning has to provide elements of environmental reinforcement and improvement.

6 INTEGRATING ENVIRONMENTAL DIMENSION INTO METROPOLITAN PLANNING BY STRATEGIC ENVIRONMENTAL ASSESSMENT AND MANAGEMENT PLANS

The need to read the territory from an environmental point of view has become a priority, and planning sciences have to transpose their theoretical basis (Battisti, 2001, p. 40).

Metropolitan planning should define overall strategy to be pursued at municipal level, where an EN may be materialised. In this sense, metropolitan planning assumes the role of coordinator for the EN, providing support guidelines for training local plan.

According to the “Manuale per la gestione dei siti Natura 2000 [Manual for Management of the Natura 2000 Sites]”, metropolitan area is one of the spatial government levels to integrate environmental concepts into planning processes (MATT, 2002).

Our opinion is that the EN could be integrated into planning as dialogue on environmental, economic, social, political issues aimed at the sustainable urban development. Conventional urban and regional plans do not always guarantee the integration of environmental objectives.

Boitani (2000), Battisti (2003) and Boitani et al. (2007) (as cited in MATTM, 2009, p. 9) explain that the EN should fit both between environmental spatial planning strategies and among those of conservation. Therefore, from this perspective it is not possible to develop strategies that may be defined without specifying conservation objectives over time and space. Indeed, relatively to EN, a weakness of plans is represented by the lack of specific objectives and indicators that can be monitored over time, so as to allow the assessment of these measures.

About ENs, the role of the SEA process, related to the metropolitan plan and management plans of the Natura 2000 Sites, becomes crucial to formulate objectives and to support the monitoring phase.

As illustrated in the previous section, a habitat suitability approach provides a picture of the potential suitability of species to environmental and land use variables considered. In addition, it is useful to represent the relationships between habitat and species in a simple and easily understandable form. The integration of this approach in planning process, placed in the SEA process of management plans and metropolitan plan, should allow for a better management of the metropolitan environment, identifying policies or practices that might cause destruction or reduction of important habitat for species. This enables to evaluate different scenarios corresponding to different changes due to planning decisions, thus closely related to land use changes (e.g. the prediction of new areas for housing, infrastructure networks, ...).

Indeed, a habitat suitability model is useful, as well as to design networks, also to address spatial planning, monitoring of network and environmental system, and to verify land use transformations (MATTM, 2009, p. 19). Numerical indicators, which take an initial state of species suitability (also in percentage terms) into account, could be implemented, and they can be monitored over time.

Analysis and modelling of ecological connectivity have been one of the objectives of several methodological studies based on ecological principles, which combine them with planning in pragmatic approaches (Marull, 2005). However, there are some restrictions, such as the difficulty to validate field data, thus their accuracy is often not high.

In our study, the model means a qualitative rather than quantitative sense, in order to provide, in a wide-area scale, decision support elements in planning process, even during the phase of environmental assessment. Moreover, specific conservation actions should be supported, in a detailed multidisciplinary context, by specific quantitative analyses. A similar approach requires: a good understanding of ecological requirements of the species within the area; uniform spatial data of the study area; and the results should be translated into estimates.

In our opinion, if the metropolitan plan is developed under the perspective of the EN integration, then its smart environmental value is highlighted by strategic policies for development and transformations. Indeed, the metropolitan plan takes the meaning of the ENs integration factor, as structural pillar of future spatial planning, and it will direct municipalities to the task of developing an EN design more detailed.

7 CONCLUSION

In this work we describe an example of an ecological analysis approach applied in the Metropolitan City of Cagliari. We use species-specific habitats suitability models to analyse the ecological connectivity, which is interpreted as the vocation of the metropolitan context to be crossed by species. In our view, this approach could be a good starting point for sustainable land management and evaluation of environmental conditions. We think that this analysis, integrated in the SEA process, allows to define objectives on protection of the ecological and natural heritage, and to improve the coherence of the Natura 2000 Network. A similar method starts from a deep knowledge of physical and functional elements with reference to the conservation of species. In addition, it can be a crucial moment in spatial planning, because taking species relationships with land uses into account, the critical points may be rapidly identified. Thus, this analysis becomes an essential element in the planning decision-making process.

In our work, this approach describes only an empirical purpose and should be accompanied by more extensive global data, in order to implement a sensitivity analysis and verify the robustness of results.

Therefore, fauna and flora specific findings would be useful to verify the correlation between the interest species presence and structural elements. In this way, this approach could be adjusted, from a simple qualitative approach, to a quantitative approach based on validated data from professionals, such as naturalists and zoologists, since this is an open field widely suitable for a multidisciplinary confrontation.

Our study shows the critical issue related to a specific species that try to cross the metropolitan area of Cagliari from East to West. The metropolitan plan, based on the concept of sustainability, might address land use choices, even considering aspects of EN, which should be even more detailed in planning in local municipalities. In our opinion, this issue is important to implement sustainability concepts into the metropolitan planning.

If the ambition of the Metropolitan City of Cagliari is to become a smart metropolitan city, at least from the environmental point of view, the Metropolitan City of Cagliari should recognise the EN existing in its context and should become aware of its environmental heritage.

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10 ACRONYMS

- CLC: Corine Land Cover
- DICAAR: Dipartimento di Ingegneria Civile, Ambientale e ARchitettura [Department of Civil and Environmental Engineering and Architecture]
- DPR: Decreto del Presidente della Repubblica [Decree of the President of Italian Republic]
- EC: European Commission
- EEA: European Environment Agency
- EEC: European Economic Community
- EN: Ecological Network
- EU: European Union
- GDP: Gross Domestic Product
- MATT: Ministero dell'ambiente, della Tutela del Territorio [Ministry of the Environment, and Protection of Land]
- MATTM: Ministero dell'ambiente, della Tutela del Territorio e del Mare [Ministry of the Environment, and Protection of Land and Sea]
- SAC: Special Area of Conservation
- SCI: Sites of Community Importance
- SEA: Strategic Environment Assessment
- SPA: Special Protection Area
- RAS: Regione Autonoma della Sardegna [Autonomous Region of Sardinia]
- REN: Rete Ecologica Nazionale [National Ecological Network]