Rete Natura 2000 Reviewed Through Territorial GIS Zoning

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Abstract The province of Grosseto in the region of Tuscany, Italy, is among the areas in Europe included in the "Rete Natura 2000" (network Natura 2000) EU directive 92/93 CEE "Habitat", for its peculiar site characteristics. Due to intensive human activities through territorial colonization, it is very difficult to find uncontaminated natural areas. This work analyses the area of Grosseto adopting and adapting the Recreation-Opportunity-Spectrum (ROS) North American Methodology to classify the territory based on human presence and related activity. It includes both natural protected environment and the immediate surrounding colonized milieu. The results of the analysis will allow developing a framework of reference for the rehabilitation projects and for improved territorial management.

Keywords Sustainable development, ROS, colonized territory, protected habitat

1 Introduction

The EU directive 92/43 CEE "Habitat", entitled "Rete Natura 2000" (network Natura 2000), in Europe aims at the protection of Biodiversity through the preservation of natural and semi-natural habitat, of the flora, and of wildlife. The project consisted in the creation of natural protected areas (Regione Toscana, 2009). The areas were selected based on the presence of particularly rare species and habitats or on the community interest from the scientific and natural points of view. Such activity was entrusted to the National Agency for New Technologies, Energies, and Sustainable Economic Development (ENEA). ENEA analyzed and located the sites with appropriate characteristics to be included in the project Rete Natura 2000 (Natura 2000 network). Accordingly, each Italian region joined the directive through the implementation of regional laws; i.e. Tuscany implemented Regional Law 6 April 2000, n. 56 (Regulations for the conservation and protection of natural and semi-natural habitats, flora and fauna) "Norme per la conservazione e la tutela degli

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habitat naturali e seminaturali, della flora e della fauna selvatiche". This law allows identifying areas of particular natural value: such as the sites of community importance (SIC) as per above mentioned habitat Directive, and special protection zones (ZPS), that were established by the Directive on the conservation of wild birds (Regione Toscana, 2009).

Human activities play a fundamental role for the preservation of biodiversity, directly and indirectly. We live in a hugely colonized territory, in which it is difficult to find uncontaminated natural spaces. The aim of this work is to analyze the territory where such areas were formed taking into consideration the immediate environment.

The directive requires the Member States, and in the case of Italy the Regions too, an obligatory result: safeguarding the areas in a satisfactory conservation state, and promoting further plans, programs and projects. The projects should not be necessarily connected to the safeguard of the site but should have an implication on the preservation of natural habitat (the sites of community importance SIC should be subjected to impact assessment approved in Italy as per article 5 of the D.P.R. n. 357/97; Presidential Decree).

The conservation objectives of the sites under project Rete Natura 2000 are defined by management plans (if existing): concerning the SICs the reference is represented by D.M. 3/9/2002[4] (Ministerial decree) - guidelines for the management of the sites Rete Natura 2000, and in the acts being established for the designation of the special conservation zones (ZSC). Concerning the ZPS the paper refers to the managerial recommendations included in the D.M. 17/10/2007[5] - Minimum uniform criteria for the definition of conservation measures relative to ZCSs and ZPSs (Regione Toscana 2009).

In the standards, each protected area is described (section 3.2). In the sub-section, entitled vulnerability, the area's health condition is considered. However, the approach is very general and is only limited to listing the possible causes of disturbance such as fire risks, the excessive presence of ungulates and coast erosion (Regione Toscana 2009).

The aim of this work is to deepen the acquaintance with these areas. This will be done by broadening the investigation to include the evaluation of the protected areas. These areas are considered at risk due to their proximity to heavily populated parts, and to their distance from safe ones. The case study consists of the whole province of Grosseto in the region of Tuscany. A zoning plan was developed in Grosseto based on the Recreation-Opportunity-Spectrum (ROS) North American methodology (Clark and Stankey 1978; Driver, 1990; Blocker et al., 1995). The plan divided the territory according to the intensity of human colonization. This plan will allow successively, analyzing the percentage of protected areas within hugely colonized ones, and the areas located within natural environments.

[4] D.M. 3/9/2002 Guidelines for the management of Natura 2000 sites

[5] D.M. 17/10/2007 Minimum uniform criteria for the definition of conservation measures related to the Special Conservation Zones (ZSC) and Special Protection Zones (ZPS)

2 Territorial Zoning Through The Application Of The ROS Methodology

The Recreation-Opportunity-Spectrum (ROS) is a North American methodology developed in the 70's aiming at classifying the territory (Canadian) based on the human presence and related human activities. The method is concerned essentially with the territorial land use and orography (geomorphology).
The aim is to create a 'zoning' plan, to be used successively in the territorial planning, or for strategic urban planning solutions. The methodology was formalized in 1982 through a ministerial decree, in which standards were defined to underpin operation phases. The standards were evaluated and amended in 1996, and a second draft was developed. The ROS was developed in British Columbia and later adopted in the United States. In 1998, procedures to unify the standards started.
The ROS considers the following three factors:

- Accessibility
- Degree of naturalness
- Degree of colonization

Different variables are defined to quantify these factors: the distance between roads, and the width of the area, allowing to define the *accessibility*, the presence/absence of human beings, the presence of accessible roads (pathways for vehicles), and the presence of human activities, to evaluate the *degree of naturalness* and the *degree of colonization*.
Based on the quantification of the three factors, the ROS provides a classification of the territory by its subdivision into six categories with increasing levels of colonization:

1. Natural;
2. Semi-natural and no vehicular access;
3. Semi-natural with vehicular access;
4. Semi-natural rural;
5. Rural;
6. Urban.

The Ministry of Forests (British Columbia), Forest Practices Branch for the RCI 1998, defines natural, the areas extending beyond 5000 hectares, 8 Km distant from roads, lacking any human activity, where it is possible to experience direct contact with natural environment, and where meeting other human being is almost impossible. The definition of Urban is the direct opposite of the latter (Clark and Stankey 1978; Driver, 1990; Blocker et al., 1995).
This methodology has resulted useful to define zoning standards. However, it was adapted to fit the characteristics of the Italian peninsula, geographically different from the British Columbia territory, and the variables considered inapplicable to the Italian territory were disregarded.

3 The Case Study: Rete Natura 2000 Areas In The Province Of Grosseto Subdivided In ROS Categories

3.1 ROS Classification Of Grosseto Province

The difference in population density between the case study and the North American reality is an essential factor to consider in applying the ROS methodology. The Canadian population density is significantly lower than the Italian population density. In Canada, the extreme climatic conditions in certain areas affect the presence, not only of human activities, but also of human beings on the territory (Clark and Stankey 1978; Driver, 1990; Blocker et al., 1995). This is certainly not the case in Italy.

To minimize such difference the province of Grosseto was selected as a case study. Grosseto (highlighted with the red circle in figure 1) presents the lowest population density in the region of Tuscany; 50 dwellers per Kilometer square, for 227.500 dwellers over a surface of 4.504 Kilometer square. Grosseto occupies the entire southern extremity of Tuscany. The Province of Grosseto currently includes 28 municipalities, including the capital town Grosseto.

Figure 1 – Province of Grosseto (highlighted with a red circle)

A ROS zoning model was developed based exclusively on three variables, reflecting the three typical factors of the ROS. The distance from roads is one of the variables chosen concerning the degree of accessibility. Land-use is the variable related to the degree of naturalness, and the distance from urban centers is the variable for degree of colonization. The three variables were uploaded in the Territorial Information System (SIT), using the following cartographic sources:

1. *Road Traffic*: the linear geometric components of the regional road network and communications promoted by the Tuscany Region in 2003.
2. *Land*-use: the CorineLand-Cover land-use map of year 2000 developed within the "CorineLand-Cover" project according to the European regulation on Geographic Information (ENV 12657).
3. *Inhabited Centers*: the dataset prepared by the Italian National Institute of Statistics (ISTAT), containing the polygons that identify the centers, the inhabited nucleus, and the spread[6] houses surveyed during the 14th general census of the population in 2001.

Typical operations and applications of the SIT were undertaken (essentially overlaying and buffering), and the case study has been subdivided into three zones, defined as follows:

Urban Areas (A_u)

Urban areas are the areas in which colonization of the natural environment is maximum; the land-use in these areas is prevalently urban and urban streets:

- S_u – Artificial Surfaces
- C_a – Inhabited Centers
- St_u– Urban Streets

Formula 1 synthesizes the definition of the urban area at the map level. The whole "urban area" (A_u) is defined by the territorial j-units belonging to the respective artificial surfaces (S_u) and corresponding, within the Corine Land-Cover, to the urbanized zones of residential land-use, the industrial zones, the commercial and infrastructural zones, the mining areas, the construction sites, to landfills and abandoned land, the green spaces, and artificial non-agricultural land (European

[6] ISTAT Definitions:

- An *inhabited center* is an aggregation of contiguous or close vicinity houses with interjecting streets, squares or similar, or however by interruptions, characterized by the presence of public services (…) in order to prove there exists an organized and properly managed social structure.
- An *inhabited nucleus* identifies the inhabited locations, lacking community public spaces, characterizing inhabited centers. It is composed of attached houses or house in close vicinity, with a minimum of five families and interjecting roads, trails, open spaces, barns, vegetable gardens (…), provided the interval between two houses is not above thirty meters and not anyway below the distance between the nucleus and the closest among spread houses.
- *Scattered Houses* are those distributed in the municipal territory, and which, distance does not allow the constitution of at least an inhabited nucleus.

Commission, 1994). Furthermore, urban centers not included in the latter category (C_a) and urban streets (the streets that are of the latter category (St_u)), belong to the urban area.

$$A_u = \{A_j | A_j \in S_u \cup C_a \cup St_u\} \quad (1)$$

Where
A_u = urban area
A_j = analyzed territorial j-unit
S_u = artificial surfaces
C_a = inhabited centers
St_u = urban street = $(St \cap S_u) \cup (St \cap C_a)$

Rural (anthropic) areas (A_a)
Colonized areas, include the parts close to urban centers, and all the non-urban areas in the vicinity of inhabited centers, as well as the roads and adjacent non-urban areas:

- S_a - Agricultural surfaces outside urban areas
- $C_{abuffer}$ - Buffer areas around inhabited centers (but outside these centers)
- St_a – Rural streets; i.e. all streets excluding urban streets.
- $S_{tabuffer}$ - Buffer areas around rural streets excluding the ones inside urban areas.

Formula 2 synthesizes the definition of rural area (area with medium human presence). The group "large area with medium human presence" (A_a) is given by the territorial J-units belonging to the agricultural surfaces located in the urban areas (S_a). These areas correspond, in the official Corine Land Cover, to the arable lands, under permanent crops, the meadows (permanent grassland), and heterogeneous agricultural areas (European Commission, 1994). Furthermore, the areas in the vicinity and outside the urban centers ($C_{abuffer}$), the rural streets (St_a), and the areas next to the rural streets and outside the urban areas ($St_{abuffer}$), are also considered belonging to the large area with medium human presence.

$$A_a = \{A_j | A_j \in [S_a \setminus (S_a \cap A_u)] \cup [C_{abuffer} \setminus (C_{abuffer} \cap A_u)] \cup St_a \cup [St_{abuffer} \setminus (St_{abuffer} \cap A_u)]\} \quad (2)$$

Where
A_a = rural area
A_j = Analyzed territorial J-unit
A_u = Urban area
S_a = Agricultural surfaces outside urban areas
$C_{abuffer}$ = Areas included 500 meters around the municipal main town and 1 Km around the provincial main town

St_a = Rural streets = St \ St_u
$St_{abuffer}$ = Areas included 500 meters around the streets.

Natural areas (low human presence) (A_n)
Include all the areas excluded in the precedent groups: mainly the rural natural areas, and non urban areas distant from inhabited centers and roads' network:

- S_n – Remaining part of the territory: all the natural surfaces outside urban areas and outside the rural areas.

Finally, the large area with minimal human presence is synthesized in formula 3. In formula 3 the group "large area with minimal human presence: i.e. the rest of the territory" (A_n) is represented by the territorial J-units belonging to the rest of the territory. In other worlds, this includes all the surfaces outside the urban areas, and the rural areas. These areas correspond, in the official Corine Land Cover, to the wooded areas, the areas with shrubs, the open areas with sparse or no vegetation, to wetlands and water bodies (European Commission, 1994).

$$A_n = \{A_j | A_j \notin (A_u \cup A_a)\} \quad (3)$$

Where
A_n = natural area: i.e. the rest of the territory
A_j = Analyzed territorial J-unit
A_u = Urban area
A_a = Rural area

Figure 2 shows results.

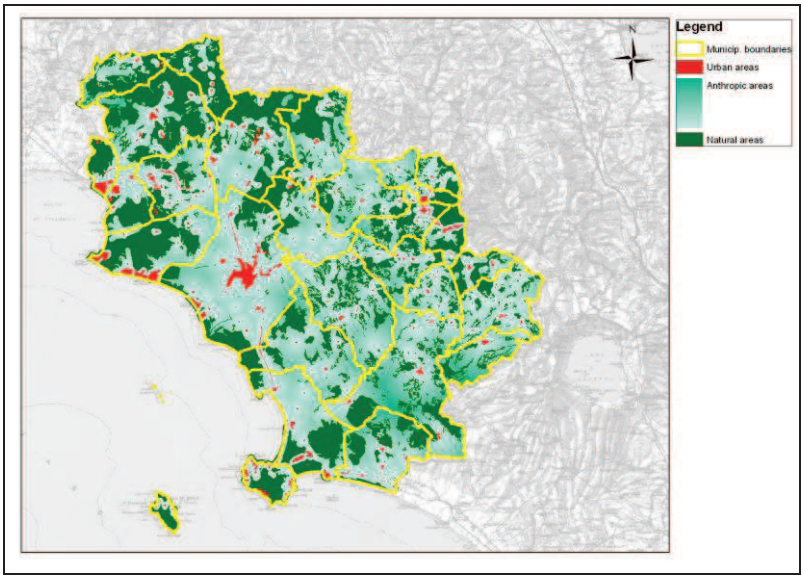

Figure 2 - ROS zoning map of the province of Grosseto

450.000 hectares of the entire province were analyzed and categorized, among which 10.170 (about 2% of the total provincial area) resulted belonging to the urban area, approximately 284.000 (63% of the whole) belonging to inhabited territories, and beyond 160.000 (35% of the whole) belonging to the natural areas.

3.2 Rete Natura 2000 Areas

The sites of community importance (SCI) are locations that contribute significantly to maintaining or restoring a natural habitat type or species in a satisfactory condition of preservation.
Each protected SCI of the Rete Natura 2000 is described in a standard form (updated in 2008) that is divided according to the following 5 points:

1. *Site identification*: the area's name is described, its code, and date of revision (updating);
2. *Site location*: the name of the region and province is indicated with related codes, surface areas, longitude, latitude, and altitude;
3. *Ecological information*: codes and habitat coverage are filled-in;
4. *Species*: the presence of species such as birds, reptiles, amphibians, fish, invertebrates, and plants is described.
5. *Site description*: the characteristics, the quality, the vulnerability, as well as the historical documentation (areas' maps) are identified (Regione Toscana 2009).

Among the Mediterranean and continental bio-geographic areas of Tuscany, 127 SIC are identified for a total of 305.378,96 ha .

The Italian Ministry of Environment and Territorial Preservation designate the SIC as Special Zones of Conservation (SZC), within a maximum period of six years, by a decree adopted in agreement with each concerned autonomous region and province.
The SZC are effectively SIC over which conservation measures necessary for the maintenance and recovery are applied by the institutions within 6 month. These maintenance measures should secure a satisfactory state of the natural habitats and/or populations of species for which the site is designated.
The special protection zones (ZPS) are foreseen and regulated by the community Directive 79/409 "Uccelli" (birds) (amended and replaced by Dir. 2009/147/CE). The aim of the ZPS is the conservation of all species of birds living naturally in the wildness. This aim can be fulfilled by protecting wild birds as well as their natural habitat. The ZPS are automatically included in the Natura 2000 network. The ZPS in Tuscany are 61, and cover a land surface of 192.645,26 ha. Among which 61.209,26 ha are water surfaces (these are extensions of ZPS in the ocean and related to the islands of Capraia, Gorgona, Pianosa, Montecristo e Giannutri). In contrast with the SIC, subject to the successive designation as ZSC, the ZPS maintain the same designation.
In the province of Grosseto approximately 73.100 ha belong to the Rete Natura 2000, 16% of the total province area. These are spread in 40 protected areas belonging to the all the Mediterranean bio-geographic region. Table 1 details the first ten protected areas in a decreasing order.

Table 1 - Protected areas in the province of Grosseto (Authors adaptations on Regione Toscana 1996 data sheet)

ID	Name	Hectares
1	Alto corso del Fiume Fiora	7102,12
2	Monte Labbro e alta valle dell'Albegna	6298,71
3	Boschi delle Colline di Capalbio	6024,30
4	Val di Farma	5962,01
5	Monte d'Alma	5842,05
6	Monte Argentario, Isolotto di Porto Ercole e Argentarola	5672,58
7	Monte Leoni	5113,01
8	Monti dell'Uccellina	4439,54
9	Cono vulcanico del Monte Amiata	4343,10
10	Laguna di Orbetello	3694,05

The above areas are geo-referenced and layered over the ROS classification previously developed in figure 2. Figure 3 shows related results while Table 2 summarizes protected areas and municipal surfaces.

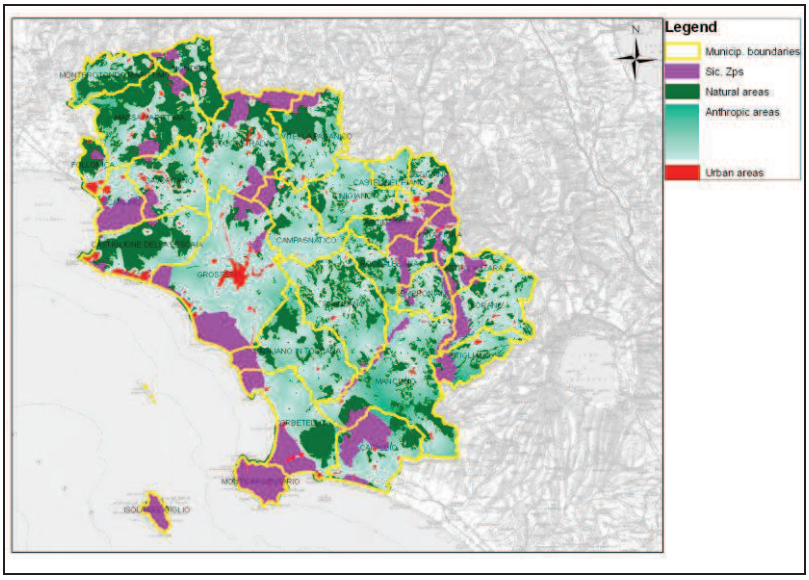

Figure 3 – Areas included in Rete Natura 2000 in the province of Grosseto

Table 2 – Protected areas and municipal surfaces

MUNICIPALITY	Municipal area	Surface protected areas	% over Municipal area	% over total protected areas
Grosseto	47611,30	9193,83	19%	13%
Roccastrada	28502,54	6585,75	23%	9%
Capalbio	18835,20	6048,19	32%	8%
Orbetello	22781,04	5873,35	26%	8%
Monte Argentario	6035,50	5651,89	94%	8%
Scarlino	8850,39	4442,36	50%	6%
Arcidosso	9417,14	3249,16	35%	4%
Manciano	37383,76	3104,73	8%	4%
Roccalbegna	12609,65	3088,48	24%	4%
Santa Fiora	6279,62	2956,84	47%	4%
Giglio Island	2449,80	2523,66	103%	3%
Sorano	17463,87	2331,61	13%	3%
Magliano in Toscana	24993,00	2259,78	9%	3%
Castell'azzara	6453,79	2051,58	32%	3%
Massa Marritima	28191,00	1867,56	7%	3%

Pitigliano	10228,32	1821,69	18%	2%
Campagnatico	16271,57	1497,82	9%	2%
Gavorrano	16641,76	1464,93	9%	2%
Civitella Paganico	19184,22	1425,62	7%	2%
Semproniano	8160,92	1186,69	15%	2%
Castel Del Piano	6880,18	1152,87	17%	2%
Montieri	10899,46	986,54	9%	1%
Seggiano	4928,70	840,05	17%	1%
Cast. Della Pescaia	20888,72	792,37	4%	1%
Scansano	27148,84	374,30	1%	1%
Follonica	4796,84	319,44	7%	0%
Cigniano	10130,86	0,00	0%	0%
Monterotondo Marittimo	16382,22	0,00	0%	0%
Total	**450400,20**	**73091,09**	**16%**	**100%**

Taking into consideration the zoning developed through the ROS methodology, approximately 27.087 ha of 73.101 ha of protected areas (37% of the total) are located in highly inhabited territory, while the remaining 46.003 ha (63% of the total) are natural areas (figure 4 and table 3).

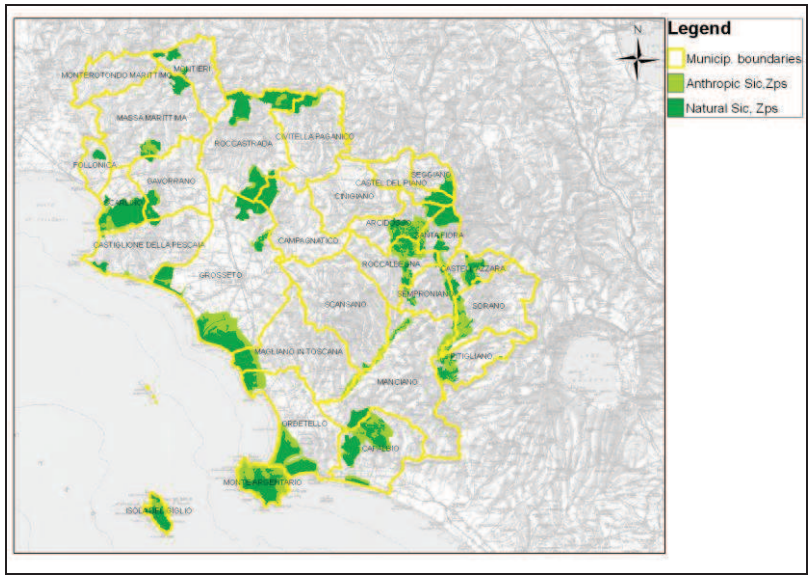

Figure 4 – Areas of Rete Natura 2000 in the province of Grosseto divided based on ROS categories

Table 3 – Protected areas subdivided according to ROS categories

MUNICIPALITYY	Rural	Natural	Total	%Rural	%Nat.
Scansano	290,39	83,92	374,30	78%	22%
Sorrano	1672,51	659,09	2331,61	72%	28%
Manciano	1880,60	1224,13	3104,73	61%	39%
Semproniano	686,12	500,57	1186,69	58%	42%
Pitigliano	947,67	878,02	1821,69	52%	48%
Monte Argentario	2891,02	2760,87	5651,89	51%	49%
Roccalbegna	1522,61	1565,88	3088,48	49%	51%
Capalbio	2935,61	3112,58	6048,19	49%	51%
Orbetello	2594,91	3278,45	5873,35	44%	56%
Archidosso	1384,13	1865,02	3249,16	43%	57%
Grosseto	3323,75	5870,07	9193,83	36%	64%
Castell'azzara	718,51	1333,07	2051,58	35%	65%
Castiglione Della	269,16	523,21	792,37	34%	66%
Magliano In	752,08	1507,70	2259,78	33%	67%
Giglio Island	799,27	1724,39	2523,66	32%	68%
Santa Fiora	931,85	2024,98	2956,84	32%	68%
Massa Marittima	555,32	1312,24	1867,56	30%	70%
Seggiano	239,00	601,05	840,05	28%	72%
Civitella Paganico	382,36	1043,26	1425,62	27%	73%
Scarlino	926,27	3516,09	4442,36	21%	79%
Roccastrada	942,37	5643,38	6585,75	14%	86%
Gavorrano	205,86	1259,06	1464,93	14%	86%
Motieri	125,76	860,78	986,54	13%	87%
Castel Del Piano	87.62	1065,25	1152,87	8%	92%
Campagnatico	27,17	1470,65	1497,82	2%	98%
Follonica	0,00	319,44	319,44	0%	100%
Cinigiano	0,00	0,00	0,00	0%	0%
Monterotondo	0,00	0,00	0,00	0%	0%
Total	**27087,93**	**46003,16**	**73091,09**	**37%**	**63%**

4 Conclusions

Rete Natura 2000 sites are areas in which Member States should secure the preservation or, if necessary, the restoration of habitat and species, in a satisfactory state of conservation. The main problem of these areas is the fact that they are generally subject to huge pressure due to human activity. Based upon the Habitat directive (art.1) the same state of satisfactory conservation is defined for habitat and for species.

The *habitat* natural distribution range can be stable or increasing; the structure and specific functions necessary for its long-term maintenance are defined and may continue to exist for the foreseeable future, and the conservation status of typical species is satisfactory. Concerning the *species,* when the trends of the populations indicate that the species continues and may persist to be viable, the natural range is

not in decline or may decline in the foreseeable future, and a sufficiently large habitat exists and probably continue to exist in order for its population survives for a long term.

Each instrument, relatively to its related scale of representation, gives very important information: management plans of SIC and ZPS allow a detailed knowledge of physical, biological, socio-economic, and environmental heritage characteristics. These data, in turn, feed into higher-level plans that coordinate and allow for a holistic understanding and therefore a proper management of the territory. However, the emerging framework of action focuses exclusively on the state of the protected areas leaving out the territory surrounding them (at least regarding Italy). The elevated degree of human activity impinges on, though indirectly, the maintenance of the minimal biodiversity characteristics. The aim of this work is to focus the attention on the surrounding territory by promoting a zoning for a case study (province of Grosseto) in order to identify possible critical protected areas beyond their *inherent state of health*. The north-American Recreation Opportunity Spectrum (ROS) method was adapted and the territory was subdivided in three areas according to the degree of human activity. The three areas where then used to understand where to place the Rete Natura 2000 areas.

The overall 450.000 ha of the entire province were classified through the ROS and subdivided into urban territory (2%), inhabited-rural areas (63%), and natural (35%).

This zoning was the starting point for the successive analysis of the 40 protected areas of the Rete Natura 2000 covering approximately 73.101 ha. (46.003 ha or 63% of which are natural areas, and the remaining 27.087 ha equivalent to 37% fall in highly inhabited territories. Grosseto embraces the major areas of Rete Natura 2000 with approximately 9.193 ha equivalent to 13% of the total protected areas (73.101 ha). It is followed by Roccastrada with 6.585 ha (equivalent to 9% of the whole protected areas), and by Capalbio with 6.048 ha (equivalent to 8% of the whole protected areas). Examining, however, the extension of the protected areas in relation to the total municipal area, the municipality of Monte Argentario has a protected surface of 94% of the municipal territory (5651 ha of a total 6036), followed by the municipality of Scarlino (4442 ha of a total 8850), equivalent to 50%.

Among these, the areas considered “safer” (highlighted in dark green in figure 4), because of their significant distance from heavily populated ones, are those located in the municipality of Campagnatico (1470 ha of a total 1496 equivalent to 98% of the entire protected area), followed by those of Castel del Piano (1065 ha of a total 1152 equivalent to 92%), and those of the municipality of Montieri (860 ha of 986 equivalent to 87% of the total protected area). In contrast, the protected areas presenting higher threats (rural areas highlighted in light green in figure 4) are mainly concentrated in the municipality of Scansano (290 ha of a total of 374 equivalent to 78%), followed by the town of Sorano including 72% ha of its protected areas located in heavily populated areas (1672 ha of a total 2331) and the municipality of Manciano with 1880 ha of a total 3104 ha (61%).

It is recommended that the effort of the administrative institution be focused on these areas suffering from huge human presence and activity.

Against a backdrop of increasing environmental policies aimed at safeguarding the environment, the importance given to the Rural Development Plans in the guidelines of the Common Agricultural Policy presenting a clear example (European

Commission, 2011), it is of fundamental importance to develop an instrument capable of guiding the public decision-maker towards correct planning choices able to perceive any environmental emergencies.
In fact the aim of this work is to propose a territorial management methodology able to widen the scope of the management plans of the SIC and ZPS, that currently are evaluated through impact assessment and strategic environmental assessment, to include all the areas around the protected areas.

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