

## **A new decision tool to achieve GIS-based conservation strategies for habitats of the European Natura 2000 network.**

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**Abstract:** Since 1992 onwards, “Habitats” Directive 92/43/EEC became a cardinal European law for the protection of biodiversity through the conservation of natural and semi-natural habitats, wild flora and fauna. As a consequence, a continental network of Sites of Community Importance (SCIs) was instituted and now it covers about 17 % of the EU territory. Article 6 of such directive underlines the importance of biodiversity conservation through the realization for SCIs, if needed, of proper management plans, recently increasing in number. A management plan based on intensive field studies and monitoring activities requires time and financial resources, which however are generally limited. Hence, we offer a rapid, cost-effective and scientifically-based decision tool aimed to achieve GIS-based conservation strategies for habitats of EU interest within SCIs and, in general, within protected areas. As a case study, we considered the priority habitat 6230\* species-rich *Nardus* grasslands (under threat due to natural reconversion and intensive cattle grazing), and the habitat 7140 transition mires (interested by pasturing and human disturbance) in a SCI in the Alps; we submitted them to a multicriteria evaluation in which indicators and weights were selected on the basis of the acquired knowledge of the study area. As a result, we were able to: a) quantify the level of existing threats, b) suggest urgent conservation strategies, and c) future monitoring activities. Our decision model might be transferable to further areas, through the proper adaptation of weights to the intensity and the frequency of acting threats.

**Keywords:** Alps; biodiversity conservation; environmental policy; “Habitats” Directive 92/43/EEC; habitat 6230; habitat 7140; habitat restoration; land use change; *Nardus* pastures; grazing impact; recreational disturbance; Site of Community Importance; transition mires; weighted linear combination.

### **Introduction**

Since 1992, “Habitats” Directive 92/43/EEC has become a cardinal European law for the protection of biodiversity through the conservation of natural and semi-natural habitats, wild flora and fauna. As a consequence of such directive, a network of Sites of Community Importance (SCIs; 21,474 sites), called Natura 2000 (which includes also 4,830 Special Protected Areas in fulfillment of ‘Birds’ Directive 79/409/EEC), was instituted. Following article 6 of Habitats Directive, which underlines the importance of establishing conservation measures for SCIs, management plans for SCIs are currently increasing in number in Europe, and several EU Member States have already framed their own rules and guidelines regarding them (e.g. for Italy, Blasi 2003). A management plan based on a proper scientific approach requires intensive field study and monitoring, involving a large commitment of time and financial resources, which are generally limited. In 2005, the Regional Administration of Lombardy, in Northern Italy, contracted the University of Pavia to create a pilot management plan of a SCI in the Eastern Alps, in Sondrio Province (Valtellina). The plan had to be written within two years, and, due to limited funding, would draw upon existing knowledge of the site (e.g., standard EU data form, EU habitat map at 1:10,000 scale ([http://www-1.unipv.it/labecove/ricerche/downloads/tav2\\_habitat.pdf](http://www-1.unipv.it/labecove/ricerche/downloads/tav2_habitat.pdf)), data on grazing pressure). To work within these limitations, we conceptualized a GIS-based (Geographic Information System-based) multi-criteria methodology which combined ground data, ecological models and decision methods (Janssen 1994; Power & Sharda 2007). Through such methodology, we aimed to create a rapid, transparent, and cost-effective tool to aid the

decision-making process in solving conflicts between nature protection and human activities within the study area (Margoluis & Salafsky 1998; Bleher et al. 2006; Seddon et al. 2007). We tested it on two EU habitats present within the SCI under study, both of which are widely spread across most of the European countries. These habitats are: 1) species-rich *Nardus* grasslands (EU habitat 6230; H-6230 hereafter, Fig. 1), which is a priority habitat, and 2) transition mires and quaking bogs (EU habitat 7140; H-7140 from now on), considered very fragile ecosystems, relatively scarce in the Southern Alps. For H-6230 we expected a natural reconversion to native scrub and woody vegetation or a floristic impoverishment due to intensive cattle grazing, and for H-7140 damages due to occasional grazing and tourist frequentation, by stamping and collecting plants.



Figure 1. The priority habitat H-6230 – Species rich *Nardus* grasslands (Gilberto Parolo)

### Materials and methods

The study area is predominantly covered by natural and semi-natural EU habitats. In spite of its high degree of wilderness, human presence is frequent within the study area, in particular with regard to cattle grazing and tourist activities. H-6230 and H-7140 polygons were submitted to a multivariate evaluation in which indicators and weights were selected on the basis of the acquired knowledge of the study area, and shared with local actors. We calculated the spatial contraction and cattle grazing on H-6230 (H-6230<sub>contraction</sub>, H-6230<sub>grazing</sub>) and occasional cattle grazing and human access on H-7140

(H-7140<sub>grazing</sub>, H-7140<sub>access</sub>). For more detailed information on data collection and multicriteria evaluation see Rossi et al. (2008).

### Results and discussion

Within the study area, seven H-6230 polygons encompass 80.07 hectares, while H-7140 is represented by 21 GIS polygons totalling 47.37 hectares. Human access and stay are facilitated by four refuges, two camping sites, three shelters, 10.201 km of roads, 10.991 km of principal tourist routes and 18.454 km of secondary paths. Five grazed areas cover 14.64% of the SCI. H-4060 (33 polygons), H-9420 (18 polygons) and H-6150 (58 polygons) cover 611.01, 254.29 and 1538.74 hectares respectively. H-6230 polygons undergo very different conditions with regard to spatial contraction and grazing pressure; the cross-tabulation between H-6230<sub>contraction</sub> and H-6230<sub>grazing</sub> (Fig. 2a) shows that id5 is impacted by above median threats for both spatial contraction and grazing pressure; this is similar for id4. By contrast, id1 and 3 bear higher values for one threat and lower values for another. Id2 and id6 are the least threatened polygons as they occupy bottom-left positions in the cross-tabulation ordination plot.

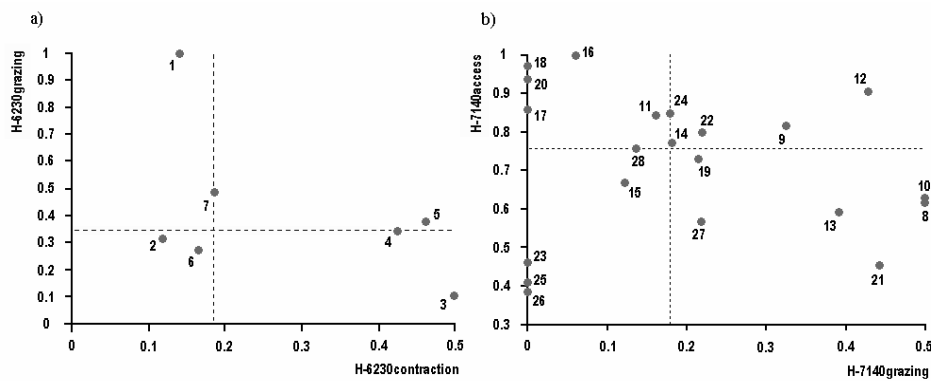


Figure 2. a) biplot resulting from the cross-tabulation of two threats affecting species-rich *Nardus* grasslands (EU habitat 6230); b) biplot for transition mires (EU habitat 7140); dashed lines represent median values; from Rossi et al. (2008), modified.

Similarly to H-6230, H-7140 polygons present heterogeneous conditions in relation to acting threats; the cross-tabulation between H-7140<sub>grazing</sub> and H-7140<sub>access</sub> (Fig. 2b) reveals that three polygons (id23, id25, id26) are nearly protected from the two quantified threats, whereas two polygons (id9 and id12) have high values for both threat indicators. Four polygons (id16, id17, id18, id20) are likely to be endangered by frequent human access, but not by the risk of occasional cattle grazing. On the contrary, four polygons (id8, id10, id13, id21) have high values for H-7140<sub>grazing</sub> and simultaneously low values for H-7140<sub>access</sub>. The outcomes of the multicriteria analyses allowed for the proposal of two management scenarios delineating differential conservation strategies for the 28 polygons belonging to H-6230 (Fig. 3a) and H-7140 (Fig. 3b).

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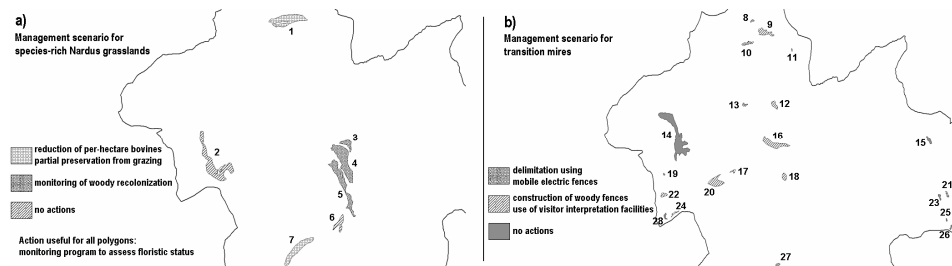


Figure 3. Conservation strategies for species-rich Nardus grasslands (a) and transition mires (b) as an outcome of the employed multicriteria decision tool; from Rossi et al. (2008), modified.

### Conclusions

Although management scenarios based on intensive field surveys are irreplaceable, this paper supports the idea that indirect GIS-based evaluations of threats, which were directly observed in the field, may allow for proper conservation strategies. This is important when a field-based alternative is not feasible due to a limited amount of time and funding. As our model is based on explicitly formulated criteria and indicators, the decision procedure may be updated easily in case of different future management scenarios.

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