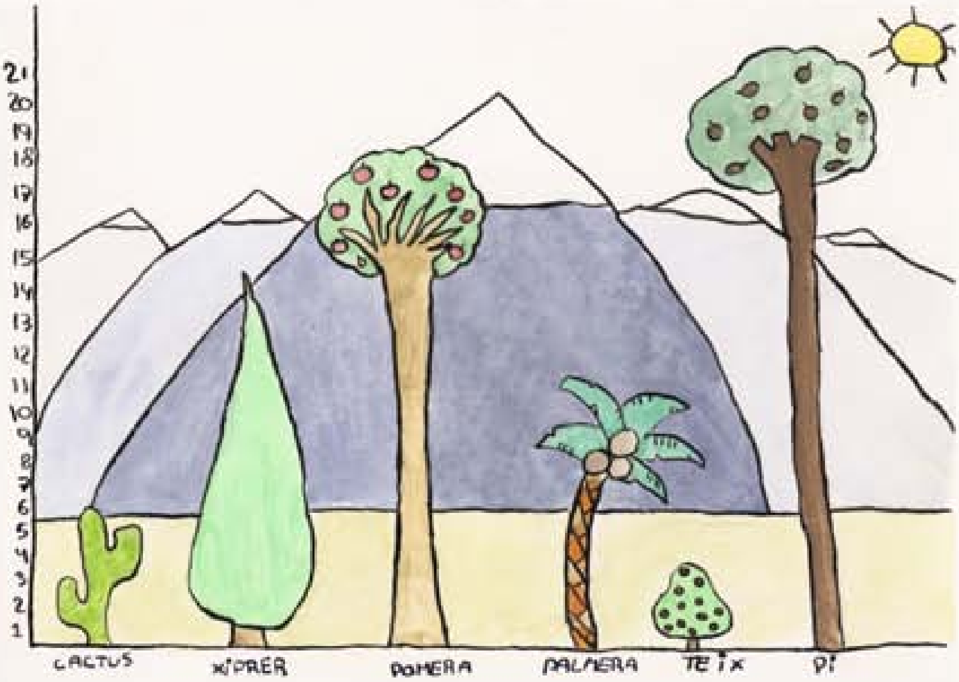
A contribution to the use, modelling and organization of data in biodiversity conservation



PhD Dissertation by

Arnald Marcer Batlle

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Supervisors: Dr. Joan Pino and Dr. Xavier Pons

PhD Programme in Terrestrial Ecology

CREAF

UAB
Universitat Autònoma de Barcelona

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A contribution to the use, modelling and organization of data in biodiversity conservation

A PhD dissertation presented by

Arnald Marcer i Batlle

with the acceptance of the dissertation's supervisors:

Dr. Joan Pino — CREAF, UAB

Dr. Xavier Pons — UAB

CREAF, Universitat Autònoma de Barcelona

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Ai festa, petapigona!

Dedicated to Helena, Anna and my parents

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List of Abbreviations

AJAX Asynchronous Javascript and XML

ANN Artificial Neural Networks

AUC Area Under the Curve

AOO Area of Occupancy

BAM Biotic, Abiotic and Movements diagram

BDBC Biodiversity Data Bank of Catalonia

BRT Boosted Regression Trees

BHL Biodiversity Heritage Library

CAPAD Collaborative Australian Protected Areas Database

CART Classification and Regression Trees

CDDA European Common Database on Designated Areas

CSV Comma-Separated Values

DAISIE Delivering Alien Invasive Species Inventories for Europe (EU funded project)

DCAC Digital Climatic Atlas of Catalonia

ENFA Ecological Niche Factor Analysis

EOO Extent of Occurrence

EOL Encyclopedia of Life

EPSG European Petroleum Survey Group

ETRS89 European Terrestrial Reference System 1989

FishNet Global Network of Ichtyology Collections

GADM Global ADMinistrative areas database

GAM Generalised Additive Models

GARP Genetic Algorithm for Rule-Set Production

GBIF Global Biodiversity Information Facility

GIS Geographical Information System

GLM Generalised Linear Models

GML Geography Markup Language

HerpNet Global Network of Herpetological Collections

IAS Invasive Alien Species

ICREA Institució Catalana de Recerca i Estudis Avançats (Catalan Institution for Research and Advanced Studies)

ICT Information and Communication Technologies

INSPIRE Infrastructure for Spatial Information in Europe

IUCN International Union for the Conservation of Nature

LAEA Lambert Azimuthal Equal Area

ManIS Mammal Networked Information System

MARS Multivariate Adaptive Regression Splines

MaxEnt Maximum Entropy

MPA Minimum Predicted Area

MTP Minimum Training Presence

OGC Open Geospatial Consortium

PAD-US Protected Areas Database of the United States

PSA Potentially Suitable Areas

ROC Receiver Operating Characteristic

SAC Spatial AutoCorrelation (in statistics modelling)

SAC Special Areas of Conservation (in European Legislation)

SCI Species of Conservation Interest (in Chapter 2)

SCI Sites of Community Importance (in European legislation)

SDM Species Distribution Modelling

SIPAN Sistema d Informació sobre el Patrimoni Natural de Catalunya (Natural Heritage Information System of Catalonia)

SPA Special Protection Areas

SQL Structured Query Language

SVM Support Vector Machines

TOL Tree of Life

UNEP United Nations Environment Programme

UTM-ED50 Universal Transverse Mercator, European Datum 1950

VertNet Global Network of Vertebrate Species

WCMC World Conservation Monitoring Center

WDPA World Database on Protected Areas

WGS World Geodetic System

XML Extensible Markup Language

WMS Web Map Service

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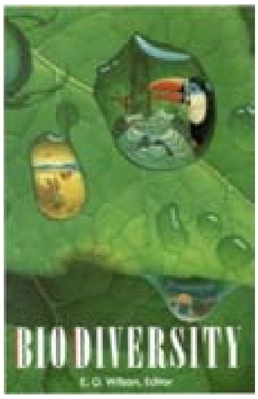
Chapter 1

Introduction



Biological diversity must be treated more seriously as a global resource, to be indexed, used, and above all, preserved. Three circumstances conspire to give this matter an unprecedented urgency. First, exploding human populations are degrading the environment at an accelerated rate, especially in tropical countries. Second, science is discovering new uses for biological diversity in ways that can relieve both human suffering and environmental destruction. Third, much of the diversity is being irreversibly lost through extinction caused by the destruction of natural habitats, again especially in the tropics. Overall, we are locked into a race. We must hurry to acquire the knowledge on which a wise policy of conservation and development can be based for centuries to come.

E.O. Wilson, 1988

1.1 Setting the problem

If we are to preserve our threatened biodiversity *we need to hurry to acquire the knowledge on which a wise policy of conservation and development can be based for* *centuries to come* (Wilson, 1988). To succeed in such an endeavour, we first need data and analytical tools to gain such knowledge and second, we need to be able to convey this knowledge to the research and conservation management communities so that it can be put to good use.

The knowledge of species distributions is fundamental in conservation practice. Ideally, in order to model the distribution of a given species, we would need a large, fine-resolution, unbiased set of presences and absences. In reality, we are often limited to sets of species occurrence data which are scarce, presence-only, biased, not extensive and at coarse resolutions (Newbold, 2010; Niamir *et al.*, 2011). Although the size of species occurrence data as a whole can be huge (GBIF, 2013a), this is not so at the level of individual taxons or species, and numerous references in the scientific literature point at that problem, *e.g.* Guisan *et al.* (2006a); Pearson *et al.* (2007); Platts *et al.* (2010). Yet, The need for information on the distribution of single species is of central importance to conserving biodiversity (Robertson *et al.*, 2010).

Our main asset to deal with this data conundrum is the wide range of analytical tools we have at our disposal. Recent advances in statistics, computer science and information technologies have allowed the emergence of the field of biodiversity informatics (Schnase *et al.*, 2003; Peterson *et al.*, 2010) and its application to conservation planning and management (Soberón and Peterson, 2004). This can be used to tackle *"the unprecedented urgency with which biodiversity needs to be indexed, used, and above all, preserved"* (Wilson (1988), p.3). The increasing digital availability of biodiversity occurrence data (Yesson *et al.*, 2007; Anderson, 2012) and protected area boundaries (IUCN-UNEP, 2013) combined with novel methods in species distribution modelling (Franklin, 2009; Peterson *et al.*, 2011) can greatly enhance the analysis of biodiversity conservation and help devise effective actions aimed at its preservation and, hopefully, succeed in the true protection of our world s natural heritage. A wide range of species distribution modelling methodologies are aimed at dealing with the wide range of data situations, from presence-only to presence-absence data (Franklin, 2009; Peterson *et al.*, 2011). Yet, the challenge is enormous.

Aim

This dissertation aims at making a contribution on methods for dealing with constraints in biodiversity data, specifically species occurrences, for producing maps useful in conservation management and plannning using species distribution modelling as a tool. It concentrates on the modelling of species of conservation interest and of alien invasive species since they embody two complementary objectives: preserving values and avoiding threats. The specific examples have been chosen because of the different particular modelling difficulties they pose: a) narrowly-distributed endemics with scarce but high quality data and b) scarce, biased, fine-resolution data of unknown quality but which have an abundant, reliable, coarse-resolution data counterpart. This latter example deals also with the equilibrium assumption problem inherent to modelling the distribution of invasive species (Václavík and Meentemeyer, 2012).

A design and implementation of an information system on protected areas which bridges the analysis of spatial patterns of biodiversity, *i.e.* species distributions, with its protection is also provided. Protected areas play a crucial role in the preservation of biodiversity (Rodrigues *et al.*, 2004b,a) and their coverage area is considered a surrogate indicator of its protection (Chape *et al.*, 2005; Jones *et al.*, 2011). If we are to monitor the progress of biodiversity protection over time, information systems are needed which can deal with changes in protected area boundaries over time. This dissertation provides a design and implementation of such an information system.

The aim of this dissertation is two-fold:

- To explore the use of scarce, problematic species occurrence data to derive information which is useful in conservation planning and management and which can contribute to the knowledge necessary to preserve the world s biodiversity.
- To use information systems technology as a tool to organize and convey information on biodiversity protection which, in combination with species distribution maps, can help the research and conservation management communities and, ultimately, society at large.

In this chapter I briefly frame the research in its broader scientific context. First, I present the nature of biodiversity data at the species level and state the need to express it in a spatial context. Second, I outline the role of species distribution modelling in providing distribution or range maps. Finally, I argue for the use of information systems for biodiversity conservation, centered on protected areas.

1.2 Biodiversity data

The term biodiversity refers to the diversity or variation in biological entities or life itself, at all levels, from genes to biomes, as well as the ecological and evolutionary processes that give birth to and maintain it. As the Convention on Biological Diversity (United Nations Environmental Programmme (UNEP), 1992) defines it as follows: Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems. The focus of this dissertation is on using primary data to obtain secondary or derived data which can be useful in the conservation of biodiversity (see Box 1). The quantity and quality of species distributional data can profoundly influence the quality of products that are then used to direct (or misdirect) conservation action (Robertson *et al.*, 2010). Figure 1.1 provides a general overview of biodiversity data. Among all of their levels, from the genes to the Biosphere, this dissertation is centered at the species data level. At this level, I will analyse the quantity and quality dimensions of data and how the different types of data require different modelling approaches. Data collection is beyond the scope of this dissertation, it will only be mentioned indirectly.

In this section we will take a broad view of two of the dimensions of biodiversity data: quantity and quality.

Quantity of biodiversity data. Data scarcity or data deluge

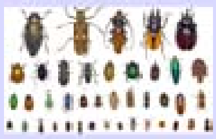
There is a wealth of data which have been recorded over the centuries in an *ad hoc* way by natural historians, museums, scientists and the like in the form of museum specimens, site inventories, citations in technical and scientific literature, etc. (Chapman and Busby, 1994; Chapman *et al.*, 2005). Over the last two decades these data have been translated into digital repositories by both governmental and non-governmental organizations, investing considerable amounts of financial resources (Robertson *et al.*, 2010). These databases represent an invaluable and still largely untapped potential asset of data for science and conservation (Funk and Richardson, 2002; Graham *et al.*, 2004; Suarez and Tsutsui, 2004; Guisan *et al.*, 2006b; Franklin, 2009; Robertson *et al.*, 2010). GBIF, the Global Biodiversity Information Facility, which collates data from digital databases around the world, exemplifies the size of existing data. Currently (as of 3 January 2012), it contains over 380 million data records coming from close to 10 000 datasets and 456 publishers, of which around 335 million are georeferenced (GBIF, 2013a).

However, despite the availability of this wealth of data as a whole, we are still far away from what would be necessary in order to be effective in conserving our biodiversity. Two terms have been coined to define the knowledge shortfall in biodiversity data. First, there is the *Linnean* (Raven and Wilson, 1992) shortfall which refers to the gap between the known species and the total amount of living species (an estimated existing 8.7 million versus 1.2 million which have been described (Mora *et al.*, 2011)). Second, there is the *Wallacean* (Lomolino *et al.*, 2004) shortfall which refers to the existing gap of information on the spatial distribution of species, that is, from our inferred distributions to the real species distributions. More recently, Ladle and Whittaker (2011) referred to a third shortfall as the gap between species extinctions by anthropogenic (past, present and future) action and real extinctions.

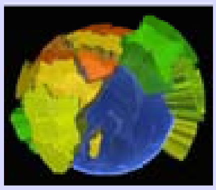
When dealing with data from single species or taxons the reality is that data are usually scarce, in contrast with the above mentioned wealth of data on biodiversity as a whole. Although methods exist for dealing with scarce data (Pearson *et al.*, 2007; Elith *et al.*, 2006; Phillips *et al.*, 2006; Bean *et al.*, 2012; Marcer *et al.*, 2012), the practical advantages of a large amount of data are undeniable not only current data but also historical, which allow us to understand changes in distributions. The major source of historical data comes from museum collections (Boakes *et al.*, 2010).

BOX 1 - Types of Biodiversity Information

Primary data - Primary data is composed of species occurrence data or raw data comprising observational data such as specimens, field notes and any direct information of observational data, held in museum collections and herbaria and in universities, governmental and non-governmental organizations and private individuals (Chapman, 2005b; Goddard *et al.*, 2011). In summary, these are data records that locate a particular species in a place at a particular point in time (Jiménez-Valverde *et al.*, 2010).



Secondary or derived data - Secondary species data are biodiversity information products such as range maps or diversity maps which are derived from primary biodiversity data. They represent downstream information products from the original occurrence records. These secondary products are needed, and are certainly attractive, but should always refer back in a repeatable and traceable manner to the primary data (Peterson, 2010).



Images sources: Kew Botanical Garden, Natural History Museum (London), Harvard University Press, W. L. R. Oliver (IUCN)

Quality of biodiversity data

The quality of this wealth of biodiversity data is far from being adequate for biodiversity planning and management. Important drawbacks include the lack of repeated observations across space and time, the lack of absence data, bias (taxonomic, spatial and temporal) and, mostly, the excessive coarseness of resolution (Margules and Pressey, 2000; Pressey, 2004).

Quality in biodiversity data is a multifaceted issue (see Figure 1.1) and several aspects of it (extent, bias, accuracy, resolution, organization and availability) may hinder its use.

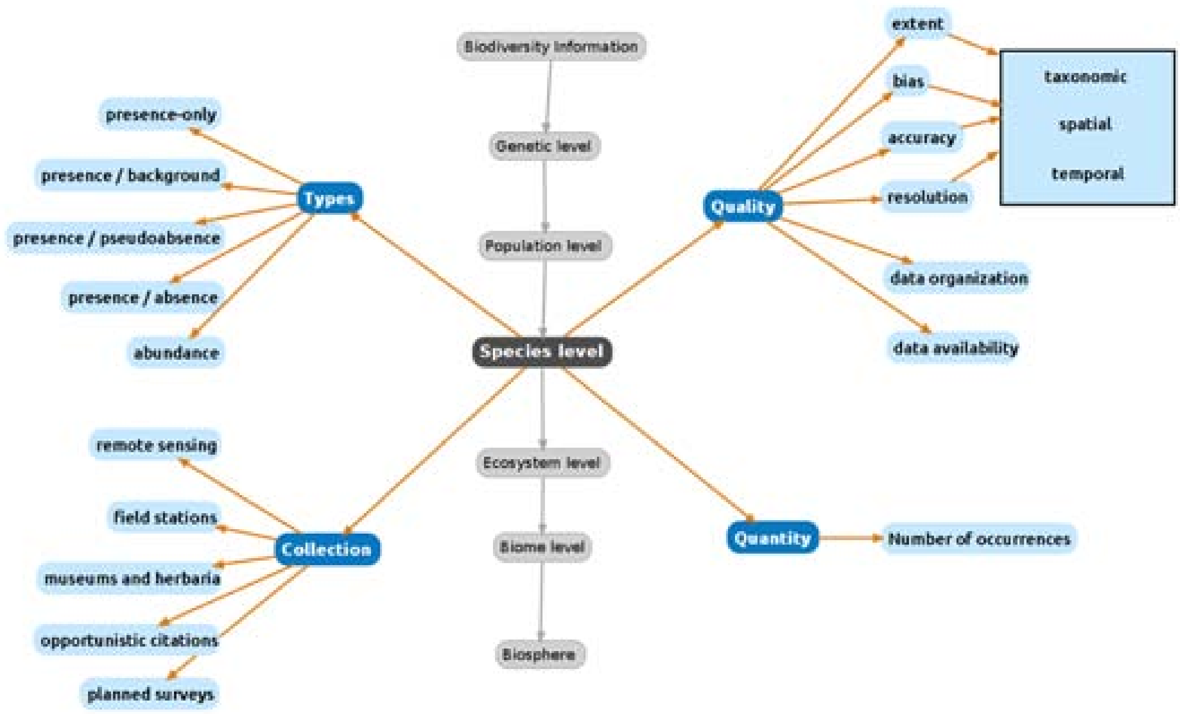


Figure 1.1: The dimensions of biodiversity data at the species level. Source: own elaboration.

Being aware of these aspects and shortcomings and having them documented as metadata is as important as solving them.

Extent The extent or comprehensiveness of the data clearly affects their usefulness in biodiversity distribution studies. It is an obvious fact that in order to know or infer species distributions in a particular area or region it is indispensable to have occurrence records from that area or region. Biodiversity is spread all over the world; however, biodiversity data is very patchy and concentrated in regions mainly of the developed world (Edwards *et al.*, 2000). For the vast majority of species, there is a shortage of data regarding their actual distribution at varying scales (local, regional, global), *i.e.* the *Wallacean shortfall*. Moreover, most data collections pertain to political or cultural geographical units hence lacking in biological meaning (Whittaker *et al.*, 2005). Not only the spatial extent is important but also the temporal and taxonomic extent of the data. Temporal extent refers to the time span for which there exist biodiversity observations. When modelling the distribution of a given species it is important to have data that matches the temporal span of the predictor variables used (Peterson *et al.*, 2011). Taxonomic extent refers to the number of taxons for which there is data; its lack known as *Linnean shortfall*.

Bias The quality of the data in relation to their extent is tightly bound to the existence of bias. Bias refers to the probability with which a given site, species or time will be sampled (Boakes *et al.*, 2010). Biodiversity data tend to have taxonomic, spatial and temporal bias (Boakes *et al.*, 2010; Martin *et al.*, 2012). This is due to the fact that, for a given study area, most of it comes from *ad hoc* studies instead of planned systematic surveys. Although data abound for parts of the world and for some specific groups of species (*e.g* plants), in other large parts of the world and for the majority of species, data describing distributions are very scarce (Newbold, 2010). Because the environment is tightly coupled with geography. Spatial or geographical bias is implicitly related to environmental bias. For species distribution modelling, the kind of bias that affects predicted distributions is precisely the environmental bias rather than the spatial bias.

Accuracy Accuracy measures the closeness of the observed value to the true value, *e.g.* how close an observed *x, y, z* coordinate of a species observation is to the true coordinate it occupies. This example refers to spatial accuracy, which affects georeferencing quality. Even with groups such as plants and vertebrates for which a larger amount of digitised data exists, a high-quality georeference for each specimen or citation is lacking (Anderson, 2012). Temporal accuracy is further facet of species occurrence data quality, but one which is not usually limiting; most species distribution studies try to infer current or potential distributions from occurrence data of a much finer resolution than that of the expected output map. Accuracy can also be applied at the taxonomic level and it reflects whether species or taxons have been correctly identified.

Resolution Research in biogeography, macroecology and conservation planning is often based on the analysis of grid maps of species richness (Graham and Hijmans, 2006). Knowing the spatial distribution of biodiversity at different scales is an important issue in conserving it (Richardson and Whittaker, 2010). What is usually referred to as spatial resolution is the size of grid cells (square being the most frequently used form). Occurrence records can take different types of georeferencing such as pairs of x,y coordinates and toponyms. In any case, they are usually converted to grid form prior to modelling exercises, except when they are already directly georeferenced as square grid cells (*e.g.* 1-by-1 km Universal Transverse Mercator cells).

Despite the fact that the term resolution is normally associated with its spatial sense, it needs also to be taken into account in its temporal and taxonomic sense. The former relates to the size of the temporal interval to which a species occurrence is associated. For example, a specimen in a natural history collection may have in its tag its year of collection which would give us a resolution of 1 year. Poor temporal resolution is more frequent with historical records, *e.g.* some old species observations can only be temporally referenced to a century.

Taxonomic resolution is the classification level at which a given individual is identified, from kingdom to levels below species (subspecies, varieties, etc.). The usual target unit for modelling is that of species (Robertson *et al.*, 2010). Lower resolution taxons such as genus (*e.g. Quercus* sp., *Bromus* sp., ...) may be more difficult to model due to the diverse ecological requirements of the species they contain. Nevertheless, predicting their distribution may be sensible in some studies (Marshall *et al.*, 2006).

Organization Data organization is quite often not taken into account when considering data quality, in spite of the fact that it ensures its consistency. Archiving in organized repositories for the long-term storage of biodiversity data within a corporate infrastructure with protocols for data entry is essential (Gioia, 2010). Ensuring a good design for the organization of data, *e.g.* through the use of relational databases, is a crucial step to avoid errors such as data duplication, orphaned keys and the like (Chapman, 2005a). Researchers have at their disposal unprecedented computer power with which to use a plethora of modelling techniques, old and new, which empowers them to perform sophisticated analysis. Each software application which implements a modelling technique requires the data to be fed in a specific custom-made format. Having correctly organized primary biodiversity data has a big impact on the efficiency with which it can be used in research, *i.e.* the time needed for data preparation and curation for modelling purposes is all but negligible. The more organized and documented through metadata the original primary data is, the easier and better their conversion for the specific analysis at hand. Metadata allows for data discovery, interpretation and appropriate use, and even automated use (Michener, 2006).

Availability Before being able to analyze and summarise biodiversity data into maps, it is necessary to make all legacy and current data about when and where species occur available and easy to use (Guralnick and Hill, 2009). Even where formalized data archiving is practised, this does not necessarily translate into easy access to data (Gioia, 2010). Despite remarkable progress in recent years, most biodiversity data in museum holdings or literature remains unavailable in an adequate digital format. In the last three decades, considerable effort has been put into the digitising of these data into publicly available species distribution atlases. Such databases represent a wealth of data on species distribution and an indispensable asset for science and conservation (Funk and Richardson, 2002; Graham *et al.*, 2004; Suarez and Tsutsui, 2004; Franklin, 2009; Robertson *et al.*, 2010). Availability can also be considered a facet of quality; for data to be used it needs to be readily available (*e.g.* through metadata-enabled discovery (Michener, 2006)). In this respect, the computer revolution, database and GIS science and technology and the Internet have become an indispensable tool in biodiversity research.

1.3 Mapping for biodiversity conservation

Conservation planning and management involve determining which areas need to be managed for the persistence of biological diversity and natural values, a task which is inherently spatial (Pressey *et al.*, 2007). The range or geographic distribution of species constitutes one of its fundamental dimensions (Anderson, 2012). Knowing the drivers that cause changes in biodiversity and where they occur is also important for devising policies for biodiversity conservation (Sala *et al.*, 2000).

Since we do not have detailed direct data on species distributions, reliable predictions are necessary (Guisan *et al.*, 2006b). We need tools to infer from incomplete data, often scarce, where these values are located. In the case of species, intensive research and development in recent years has produced a set of powerful inference tools for species distribution modelling (see Figure 1.5). These are now available to exploit the wealth of data increasingly held in easily accessible biodiversity databases for uses such as the call for a reduction on biodiversity loss made by The Millenium Development Goals and the Convention on Biological Diversity (United Nations Development Programme, 2009; Convention on Biological Diversity, 2010). Filling the biogeographical information shortfalls and improving the accuracy of forecasts are challenges which lie ahead in the field of conservation biogeography (Richardson and Whittaker, 2010; Ladle and Whittaker, 2011). In summary, we need maps of values, of threats and of sites to protect.

Maps of values. As it has already been stated, biodiversity refers to the variability of life on Earth, at all its levels, from genes to ecosystems and biomes, which leads us to the deduction that probably there should be conservation strategies in all of them. Arguably, the most prominent discrete unit of biodiversity is that of species. Species provide us with innumerable values and services: social, economical and spiritual. For these to be preserved we first need to locate where they are distributed and what their ecological requirements are; *i.e* we need maps. Given the sheer number of species on Earth, we have to set priorities to allocate limited economic and human resources available.

Specially rich areas or hotspots (see Figure 1.2) need to be identified and mapped in order to optimally allocate these limited resources. Hotspots have exceptional concentrations of endemic species which, at the same time, are under significant habitat loss (Myers *et al.*, 2000). One of such areas is the Mediterranean basin. Current technologies and tools can be used to perform fine analysis of the distribution of species in hotspots susceptible to be protected.

Maps of threats. Numerous studies exist that analyse the pressure or threats posed to Earth s biodiversity (Sala *et al.*, 2000; Petit *et al.*, 2001; Gerard *et al.*, 2010). Along with

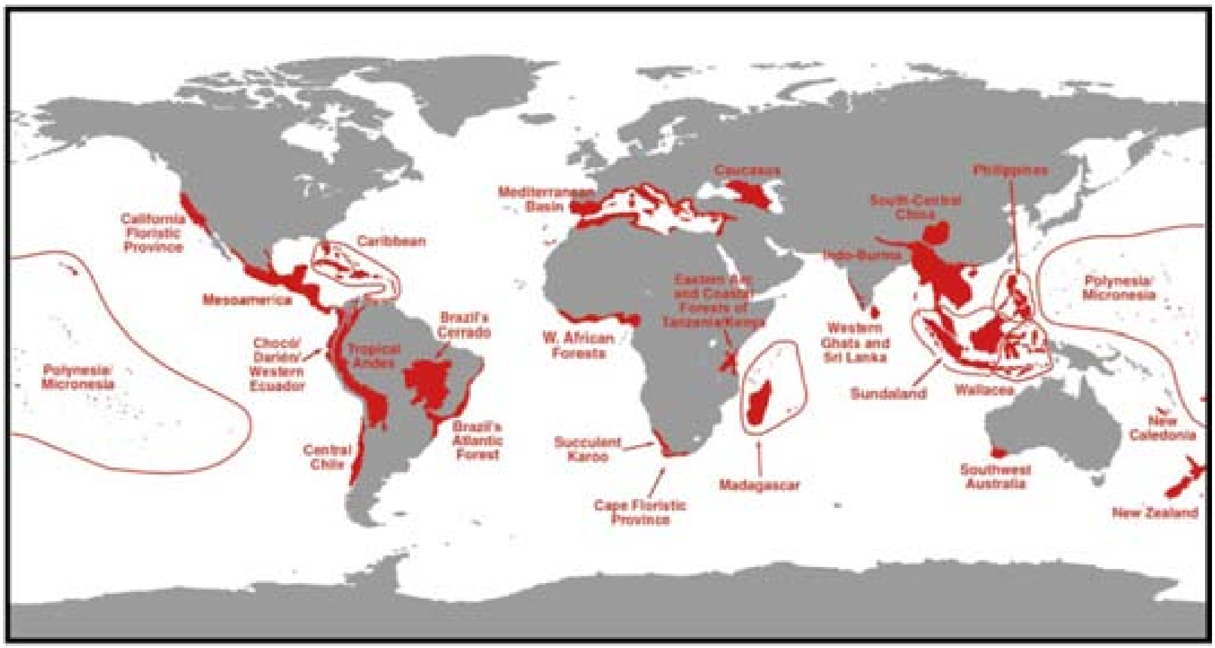


Figure 1.2: 25 biodiversity hotspots as proposed by Myers *et al.* (2000)

habitat destruction, land conversion for agriculture and development, climate change and pollution, invasive species constitute a growing threat to native biodiversity (IUCN, 2013; Andreu and Vilà, 2011). Their spread outside their natural past or present distribution cost our economies on the order of hundreds of billions of dollars each year (Kettunen *et al.*, 2008; Butchart *et al.*, 2010; Vilà *et al.*, 2011; Pyšek *et al.*, 2012; United Nations Environmental Programmme, 2013).

Thus, apart from giving protection where values lie, we also need to identify areas that may be affected by negative vectors such as invasive alien species (IAS) in order to prevent or mitigate their spread. Developing risk maps representing the potential distribution of IAS is a necessary step towards effective management (Peterson and Vieglais, 2001; Sharma *et al.*, 2005; Roura-Pascual *et al.*, 2009; Richardson and Whittaker, 2010; Jiménez-Valverde *et al.*, 2011). It is necessary to make the best use of all available information for maximizing the limited financial resources (Nielsen *et al.*, 2008).

As an example, Figure 1.3 shows the global distribution of *Ailanthus altissima*, a global invasive tree native to China and North Vietnam which conspicuously colonises a broad array of native habitats, often with prolific populations, displacing native species, among

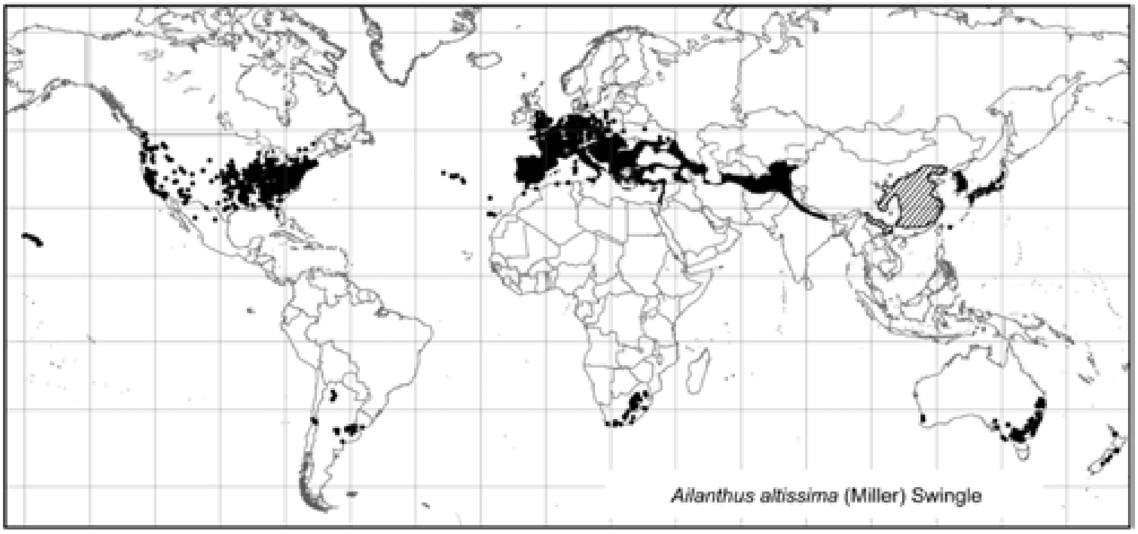


Figure 1.3: World distribution of *Ailanthus altissima*, a global invasive tree native to China and North Vietnam (Kowarik and Säumel, 2007). Native range is shown as striped polygons while invaded range is shown as black points and polygons.

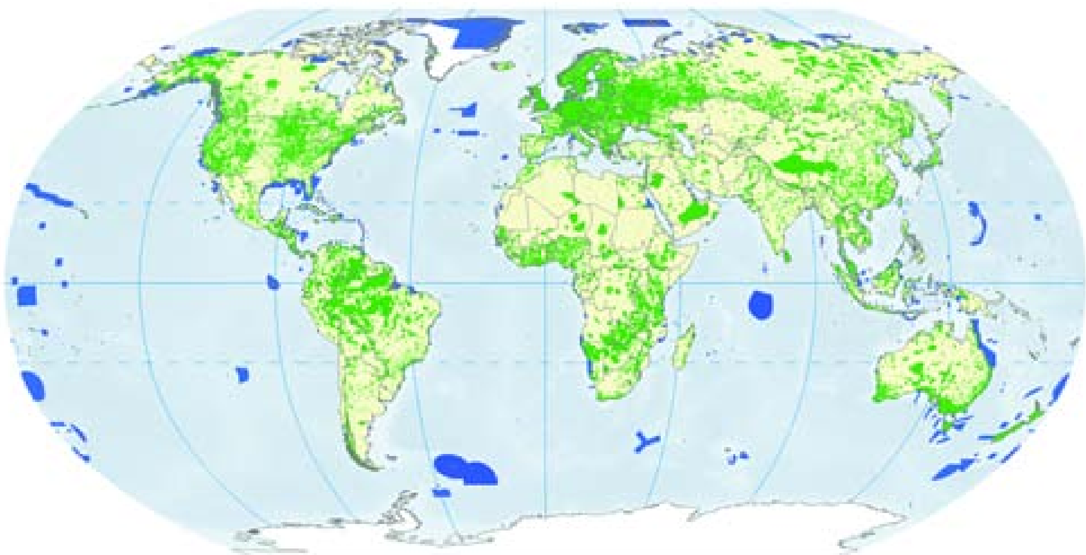


Figure 1.4: The World Database on Protected Areas (WDPA) Monthly Release, by IUCN and UNEP-WCMC, October 2012. In blue: fully or partially marine, in green: terrestrial

other impacts.

Maps of protected sites. Protected areas are a cost-effective measure to protect biodiversity (Bruner *et al.*, 2001; Balmford *et al.*, 2002; Rodrigues *et al.*, 2004b). They are land or marine areas which have been designated as such in order to preserve natural values chosen by society, groups or individuals (Ladle and Whittaker, 2011). In conservation planning, boundaries of protected areas are a vital piece of information. Most protected area boundaries have been delineated with incomplete knowledge of the distribution of the biodiversity values they intended to protect (Rondinini *et al.*, 2006), leaving *gaps* of protection as a result. As more and more information becomes available and new modelling tools are being developed, these gaps need to be assessed and solved (*e.g.* through gap analysis (Scott *et al.*, 1993)). To accomplish this, cartography on protected areas boundaries is needed. In order to assess the level of biodiversity protection we need digital geodatabases on protected areas boundaries (see Figure 1.4).

In summary, the combination of maps representing the values to preserve, the threats to avoid and protected area boundaries can empower decision-makers when taking conservation actions. Species distribution modelling allows for the generation of distribution maps out of occurrence data.

1.4 Species distribution modelling

Species distribution modelling (SDM) is a set of statistical tools which, by combining observations of species occurrences and environmental data, allow us to hypothesise the conditions under which species can survive, and thus to delimit the areas where we might expect to find a species (Elith and Leathwick, 2009; Higgins *et al.*, 2012). SDM is also often cited under different terms such as environmental niche modelling, ecological niche modelling or habitat suitability modelling in the scientific literature.

SDM has experienced an explosive growth in recent years, enhanced by the increasing general availability of occurrence data in digital databases, from sources such as natural history collections and the scientific literature among others, and by new developments in statistics and information technology (Graham *et al.*, 2004; Phillips *et al.*, 2006; Franklin, 2009; Elith and Leathwick, 2009; Peterson *et al.*, 2011).

SDM can be aimed at answering two different kinds of questions: a) *why* are species distributed the way they are, and b) *where* are species distributed. In the first case, the goal is to identify the environmental variables determining the distribution of the species across geographical and environmental space. In the second case, the goal is to predict where the species may be present. Each case serves different purposes: in the first case, understanding the ecological requirements and constraints of the species; and mapping the species distribution, usually for conservation purposes (conservation planning, reserve design, biodiversity assessment, etc.).

Justification for SDM. If we had direct occurrence data for every species at any given scale and time frame, SDM would not be needed. Provided we also had extensive environmental and biotic data, also at any given scale and time frame, we would be able to calculate the environmental niche of any given species at any given moment in time. However, such ideal conditions of data availability are far from being met even for any given single species. Although in some cases data may seem abundant, they are still very scarce for such a goal. Moreover, given the vast number of species and the limited human and economical resources available, achieving this monumental task may never be in our reach, at least in the foreseeable future. Given the global pressing conservation needs and the need to understand how species respond to their environment, SDM are an invaluable set of tools at our disposal.

SDM and data availability. In order to infer species distributions, we need data on species presences and absences as well as data on the biotic and abiotic environments which determine the ecology of species. With these, we can fit a function between the response variable (presence/absence) and the set of independent variables or environmental predictors (biotic and abiotic). With respect to the environmental predictors, while there is a growing availability of extensive spatially-explicit data on abiotic predictors (temperatures, precipitation, soil, etc.), extensive spatially-explicit data on biotic predictors is rarely available. With respect to the response variable, the vast majority of data available are only presences. Having data on species absences is the exception rather than the norm. Moreover, when data on species absences is available, it is at least subject to discussion, since true species absences from geographical space are very difficult to confirm (Anderson, 2003). Such situation about data requirements and availability has driven the development of a plethora of modelling methods, specifically tailored to deal with different scenarios of data availability (see Figure 1.5). When only presence data is available several strategies are possible (Figure 1.5): a) use only presences (BIOCLIM, HABITAT, DOMAIN, SVM), b) create pseudoabsences by sampling the area where the species has not been cited (GARP) and c) use only presences and compare them to the environmental background in which they occur (MAXENT, ENFA).

Modelling without absence data

Methods that can infer species distributions from presence-only data are very much in need since there are vast stores of such data held in natural museums and herbaria and absence data is rarely available (Graham *et al.*, 2004; Phillips *et al.*, 2006). As we have seen, several methods exist to model species distributions when there is no absence data. Among these, the maximum entropy modelling approach (Maxent) stands out among the best performers for this kind of data even when data are scarce (Elith *et al.*, 2006; Hernandez *et al.*, 2006; Phillips and Dudík, 2008; Wisz *et al.*, 2008; Elith and Graham, 2009; Thorn *et al.*, 2009; Costa *et al.*, 2010) and bias is present (Rebelo and Jones, 2010). Although Maxent is not a strict presence-only method like BIOCLIM or DOMAIN, it has better discriminatory power (Peterson *et al.*, 2011). Maxent uses presence-only data in combination with data on environmental variation across the study area, background data in Maxent terms.

Maximum entropy modelling Maxent is a general-purpose method for making predictions or inferences from incomplete information. It originates in the field of statistical machine learning and is widely used in other knowledge fields as diverse as astronomy, signal processing or natural language processing (Jaynes, 1957; Phillips *et al.*, 2004, 2006). Recently, this modelling technique has been widely used by the species distribution modelling community thanks to the fact that it has been adapted, made easily available through a specifically-developed software package (with a user-friendly interface), tested and specifically explained for ecologists (Phillips *et al.*, 2004, 2006; Elith *et al.*, 2011). There are abundant examples of its application to many kinds of distributional studies:

species richness (Newbold *et al.*, 2009), invasive species (O Donnell *et al.*, 2012), climate change effects on species distributions (Franklin *et al.*, 2012), endemism areas (Herzog *et al.*, 2012), protection quality (Nóbrega and De Marco Jr, 2011) and rare species (Marino *et al.*, 2011) among others.

Maxent (Phillips *et al.*, 2004, 2006; Elith *et al.*, 2011) uses data on the environmental background on which the species exists and tries to estimate a probability distribution which is the most uniform or spread out and, at the same time, which satisfies the constraints imposed by the available occurrence records and the environments in which they occur but no more (Phillips *et al.*, 2006). In other words, it estimates the target distribution of the species with maximum entropy, subject to the constraint that the expected value of each feature under this estimated distribution matches its empirical average. This distribution agrees with only what is actually known and avoids assumptions not supported by the data. According to its authors (Phillips *et al.*, 2006), its main advantages are: a) it requires only presence data and environmental information for the study area, b) it works with both continuous and categorical data and their interactions, c) it is deterministic and amenable to mathematical analysis, d) over-fitting is avoidable, e) bias can be treated, f) output is continuous, which allows to set different thresholds to produce binary maps and, g) it works well with scarce data. Its main disadvantages are: a) it is not as mature a method as other classical statistical approaches such as GLM (Nelder and Wedderburn, 1972) or GAM (Hastie and Tibshirani, 1986), b) regularization needs to be studied and applied to overcome over-fitting, and c) it needs specific software.

The software package offers the possibility to work on *Auto features* mode, which means that Maxent decides which kind of functions to fit depending on the nature of the data it is fed. This is a widely used operating option since Maxent has already been calibrated to work with different species pertaining to different taxonomic groups, with different number of occurrence records and different species prevalence (Phillips and Dudík, 2008). The user has the freedom to choose among different fitting possibilities (linear, quadratic, product, threshold and hinge). The *hinge* option approximates it to a GAM (Elith *et al.*, 2011).

The output of Maxent are raw probabilities which sum to one across the whole studied area and is, hence, scale dependent (Phillips and Dudík, 2008). Since the raw format in Maxent can be difficult to interpret, recent versions of Maxent include a logistic output which estimates the probability of presence or suitability of the site for the species (Phillips and Dudík, 2008). However, since absence data is not used, results should be interpreted as potential relative suitabilities of each site of the study area in relation to the general background available (Phillips *et al.*, 2006). In order to estimate a true probability of presence, information on absences should also be available and fed to the model (Peterson *et al.*, 2011).

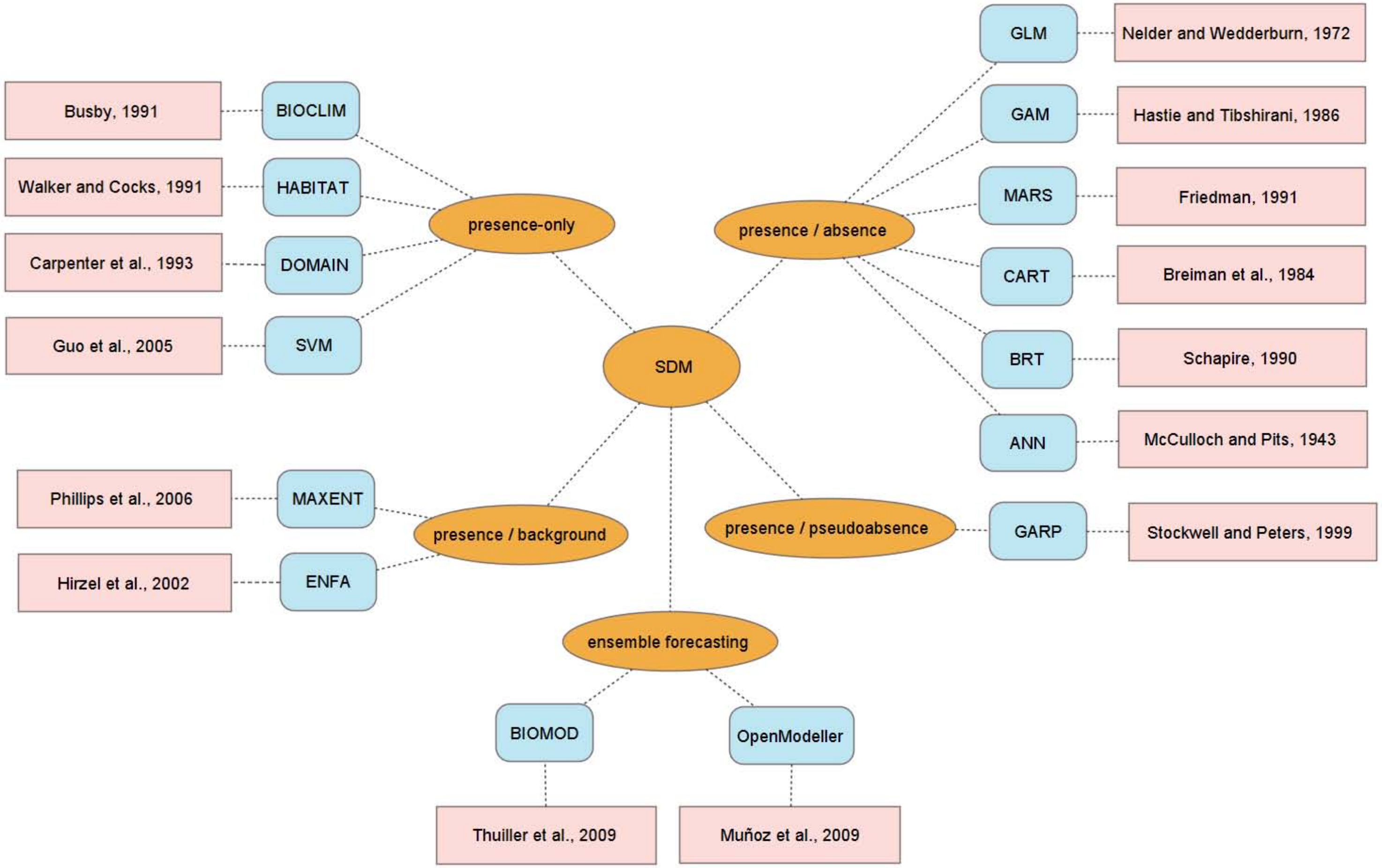


Figure 1.5: Main species distribution modelling methods by types of data. Source: Own elaboration, partially based on Franklin (2009) and Peterson *et al.* (2011)

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Model calibration and validation

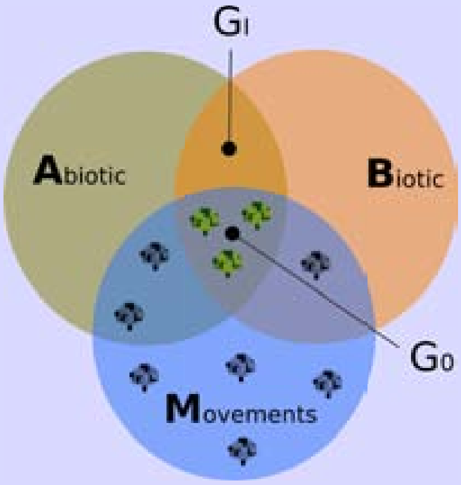
When calibrating a model it is necessary to have a clear conceptualization of the parameters involved and the extent of that study area. In this respect, Soberón and Nakamura (2009) proposed the BAM diagram, a heuristic scheme useful for analyzing the interplay between movements, abiotic and biotic environments (see Box 2).

In model calibration, parameters are adjusted so that model output validation achieves a defined degree of performance, *i.e.* agrees with observed data. Datasets for calibration and validation should be independent of each other. In an ideal situation, a separate independent set of occurrence data would be held out of calibration data and would be used to evaluate the performance of the generated model. The main goal of calibration is to develop a model that fits well to data but which, at the same time, does not over-fit (Peterson *et al.*, 2011), that is, it works well with other sets of data.

When calibrating a model, the choice of environmental predictors is an important decision. They should be chosen based on biological reasons (Elith and Leathwick, 2009), *i.e.* variables known or suspected to have an influence on limiting the distribution of the species being modelled at the given scale and time frame. Very often, this information is not known before running the model itself. Actually, the modelling process itself is often used to determine which variables affect species distribution. Usually, an iterative sequence of model runs helps in deciding the best final set of predictors. Another issue to take into account is the autocorrelation among predictors since it can hinder model interpretation (Dormann *et al.*, 2008). A possible solution is using principal component analysis to transform the variables into a set of orthogonal uncorrelated variables. However, when the purpose of the study is predictive only, as in this thesis, autocorrelation can be left untreated as it does not affect Maxent predictive performance (Kuemmerle *et al.*, 2010).

BOX 2 - The BAM Diagram

The BAM (biotic, abiotic, movements) diagram is a heuristic scheme to illustrate the relation between the biotic, abiotic or environmental and movement environments in SDM introduced by Soberón and Nakamura (2009). It helps to represent and visualize as a simple model a much complicated reality with interplays between environment and biology.



The **A** (abiotic) circle represents the geographical region where the abiotic environmental conditions meet the species requirements for its survival. **B** is the region where biotic conditions (competitors, predators, etc.) allow for the existence of viable populations. Finally, **M** is the region which has been accessible to the species dispersal over time. $\mathbf{G}_0$ is the intersection $\mathbf{A} \cap \mathbf{B} \cap \mathbf{M}$, which represents the actual distribution of the species. $\mathbf{G}_I$ is the intersection $\mathbf{A} \cap \mathbf{B} \cap \mathbf{M}^c$, which represents the potential distribution areas of the species, that is, reachable areas not yet colonized. Black tree icons represent true absences of the species while coloured tree icons represent presences. Different modelling techniques using different kinds of data calculate different concepts. When no absence data is available, what is being calculated is $\mathbf{G}_0 \cup \mathbf{G}_I$. $\mathbf{G}_0$ can only be estimated when true absence data is available, which is seldom the case. In the case of presence-only modelling with background data, the background data should be extracted only from **M**.

$\mathbf{M}^c$ stands for complementary of **M**

With respect to occurrence data, it is often the case that no independent dataset on which to evaluate performance is available. Under these circumstances, an accepted approach is to randomly choose a given percentage of occurrences, not to be used during the calibration process, and keep them apart as a test dataset. A better approximation are cross-validation techniques, usually k-fold cross-validation (Fielding and Bell, 1997). In k-fold cross-validation, the available dataset is divided into k groups. Then, the model is built with k-1 groups and the k^{th} group is used for validation. This procedure is then repeated k times until all groups have been used for validation. A particular case of cross-validation is the *leave-one-out* technique, in which, as its name indicates, groups are composed of one single occurrence (k equals the number of occurrences). *Leave-one-out* techniques are a useful option when data are very scarce (Pearson *et al.*, 2007). Still another option is bootstrap sampling, *i.e.* sampling with replacement. Cross-validation techniques ensure that any given point is used both in calibration and in testing. Also, k estimates of accuracy are obtained, which can then be averaged to have a final performance estimate with standard deviation. Finally, a measure of fit of the model to the data is obtained.

Performance measures The accuracy of species distribution models needs to be quantified in order to evaluate predictive ability. Predictive ability or performance refers to how close the predicted distribution is to the observed data and hence to the actual distribution. However, questions such as how credible the model is in ecological terms should also be addressed, specially when the modelling aim is to explain the species distribution (Franklin, 2009). Errors are inherent to modelling since models are approximations to the real world which leave unexplained variance. Errors can arise from factors such as model misspecification (*e.g.* choosing an inadequate set of predictors), data errors (*e.g.* introducing spatial error when georeferencing or misidentifying a species) and choice of an inadequate modelling technique, among others.

Model outputs are in the form of continuous probability maps. If, as in most cases, the desired outcome are binary maps (presence/absence or suitable/unsuitable areas), they need to be converted by setting a cut-off threshold. All sites, *i.e.* pixels or grid cells, with a probability value below the selected threshold are assigned to 0 and the rest to 1. With a binary map the performance of a model, how it classifies each occurrence point, can be evaluated. There are two types of model performance measures: a) threshold-independent, which evaluate performance across all thresholds and, b) threshold-dependent, whose performance evaluation is bound to a specific threshold.

Any given measure of performance uses a confusion matrix of predicted versus observed values (Table 1.1). With this matrix the number of true positives and negatives and false positives and negatives can be obtained and then used to calculate different performance measure indices (Sensitivity, Specificity, False negative rate, False positive rate, Kappa, etc.).

Table 1.1: Threshold-dependent accuracy measures, after Franklin (2009)

		OBSERVED		
		PRESENT	ABSENT	
PREDICTED	PRESENT	True positive	False positive	Total predicted present
	ABSENT	False negative	True negative	Total predicted absent
		Total observed present	Total observed absent	

Threshold-independent measures. Threshold independent measures much better than threshold-dependent measures in one sense; they allow to validate the model as a continous probability map and therefore, once validated, it can be used for different purposes by setting different thresholds to convert them to binary maps (Franklin, 2009). However, behind the scenes, thresholds are still actually set to measure accuracy across the probability range.

Probably the most widely used threshold-independent accuracy measure is the Area Under the Curve (AUC), a parameter of the Receiver Operating-Characteristic (ROC) curve (Hanley and McNeil, 1982). The ROC curve is a graphical representation of the trade-offs between false positives and false negatives at any given threshold and its AUC relates to the probability of ranking higher a species presence than a species absence. In this kind of plots, an AUC of 0.5 means that the classifier is not better than random and above 0.5 that the classifier is better than random. When evaluating presence-only models, this measure can be interpreted as an indication of the discrimination between presence of the species and background rather than presence and absence (Phillips *et al.*, 2009). Liu *et al.* (2009) lists other threshold-independent measures of accuracy which can be used in SDM, among them the Maximum Overall Accuracy, the Maximum kappa, the Gini index and the point biserial correlation coefficient.

Threshold-dependent measures. In contrast with threshold-independent measures of performance, these measures refer only to a given threshold value. If different thresholds need to be used for the purpose at hand, then each generated binary map needs to be evaluated separately. Prior to measuring accuracy a threshold must be set to convert models to binary maps. There are many different options for threshold setting and they have been discussed by many authors (Liu *et al.*, 2005; Jiménez-Valverde and Lobo, 2007; Freeman and Moisen, 2008; Nenzén and Araújo, 2011; Jiménez-Valverde, 2012; Bean *et al.*, 2012). Many of the threshold options rely on having both presence and absence data, which is not available in presence-only modelling. Without absence data these thresholds cannot be calculated. For presence-only data, several thresholding options exist, among them: fixed threshold like 0.5 (Li *et al.*, 1997; Manel *et al.*, 1999; Bailey *et al.*, 2002), Minimum Predicted Area (MPA) (Engler *et al.*, 2004) and Minimum Training Presence (MTP) (Pearson *et al.*, 2007).

The fixed threshold option is quite an arbitrary one and could be left to cases where a very conservative approach is needed, *e.g.* if 0.5 is chosen anything any better than random will be predicted as present/suitable, or also, when a predefined overall predicted area is needed. The other two thresholds are much more meaningful. MPA minimizes omission errors and the area predicted to be suitable. Models with lower MPAs are more parsimonius and, therefore, could be considered better (Franklin, 2009). The MTP threshold is equivalent to the lowest estimated value at the site of any occurrence point. This option sets the cut-off at a point where, by definition, all observed occurrence records will fall inside the predicted area, thus ensuring a zero omission rate. MTP is a very appropriate option when the purpose is to define suitable areas for conservation with a set of occurrence data which is known to be free of georeferencing and identification errors. Also, MTP makes sense ecologically since it includes all sites that are at least as suitable as those where the species has been recorded as present (Pearson *et al.*, 2007).

Model outputs: distribution or range maps

Species distribution or range maps reflect either the species presence or its terrain-suitability across geographical space; which is very useful information in conservation planning and management (Robertson *et al.*, 2010). Species richness across space is very heterogenous (Gaston, 2000) due to the widely different types of species distributions: scattered, clustered, etc. Species distribution can be defined as the set of all grid elements in a specific sampling period of time where the probability of finding the species exceeds some given threshold (Peterson *et al.*, 2011).

Knowledge of species distributions or ranges is necessary to elaborate specific action plans for their conservation and ensure their inclusion in protected areas, two important conservation actions to ensure species survival (Cuttelod *et al.*, 2008). Several methods exist to generate species range maps: point occurrence data, expert-drawn maps, species distribution models and hybrid approaches (Graham and Hijmans, 2006). Before the availability of modern modelling techniques and extensive digital readily-available environmental data, range maps needed to be drawn by expesrts or directly derived from observations in grid format. Currently, SDM allow us to infer probability maps of species presence which, in conjunction with threshold setting, can be converted into binary maps, *i.e.* range maps.

The species range area of these maps depends on the scale at which they are generated. In general, since species can not be mapped down to the actual size of their individuals, they must be generalized to some spatial resolution value. Modelled species range maps can then be used to assess species conservation and protection and to generate maps of biodiversity richness and hotspots by overlaying individual species maps, which can then be used in biodiversity conservation planning. Also, when applied to alien invasive species, these maps can be used to guide conservation actions specifically tailored to avoid species invasions and the resulting impoverishment in native biodiversity (*e.g.* Thuiller *et al.* (2005); Wilson *et al.* (2007); Václavík and Meentemeyer (2012)).

Use of species range maps in conservation

Distribution or range maps derived from SDM have important direct applications in conservation: biodiversity discovery (populations, species limits, unknown species), conservation planning, species reintroductions, vulnerability to invasion, planning protected areas, etc. (Peterson *et al.*, 2011). Species geographic ranges, and their change over time represent fundamental ecological and evolutionary characteristics of species which have direct use in assessing and predicting extinction risk (Gaston, 2003), a fundamental concept in conservation biology.

Species ranges and risk of extinction Range size is one of the main measures in evaluating the risk of exinction of a given species. In particular, two measures of size are used for such purpose, the Extent Of Occurrence (EOO) and the Area Of Occupancy (AOO). IUCN (2001) defines EOO as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, *i.e.* the area that lies within the outermost geographic limits of the occurrence of a species. It is normally measured by the method of the minimum convex polygon or convex hull of all occurrence data. AOO is defined as the area within its EOO which is occupied by a taxon, excluding cases of vagrancy (IUCN, 2001). The size of the AOO is dependent on the scale, the grain size or resolution, used to map the species. IUCN suggests to use a grid size of 2x2 km to measure it. EOO and AOO measures are used in criteria B1 and B2 of IUCN red listing guidelines (IUCN, 2001; IUCN Standards and Petitions Subcomittee, 2011).

Analyzing species protection Protected areas are a crucial tool in reducing the risk of species extinction, hence in conserving the world s biodiversity (Rodrigues *et al.*, 2003; Chape *et al.*, 2005; Barr *et al.*, 2011; Butchart *et al.*, 2012) and thus, in reducing the risk of species extinction. The combination of spatially-explicit models of species of conservation interest with existing reserve networks can be a very powerful tool in conservation management and planning.

These types of analysis are paramount to answering a question of importance to the conservation of biological diversity: how effective are protected areas at conserving biodiversity ? (Margules and Pressey, 2000; Brooks *et al.*, 2004; Chape *et al.*, 2005; Langhammer *et al.*, 2007; Suthterland *et al.*, 2009). This can be answered by gap analysis (Scott *et al.*, 1993; Rodrigues *et al.*, 2003; Brooks *et al.*, 2004; Dudley and Parish, 2006; D Amen *et al.*, 2013).

Systematic use of gap analysis is an important tool in identifying conservation gaps, provide conservation information for conservation managers, guide specific resource management activities and mitigation actions to counter the effect of climate change (U.S. Geological Survey, 2013; United Nations Environment Programme, 2013). Gap analysis is interpreted as a strategy for achieving comprehensive, representative and effectively managed networks of protected areas. In gap analysis, explicit biodiversity representation targets are spatially set and then compared to the existing network of protected areas in order to analyze to which degree they are met. Then, priorities for expanding the protected area network, based on the principles of irreplaceability and vulnerability, are identified to achieve the targets for all features (Langhammer *et al.*, 2007). This information can then be combined with spatial layers of land ownership, stewardship and management status in order to correctly direct conservation action (Scott *et al.*, 1993; Jennings, 2000).

Preventing IAS spread Not only identifying the intersection between conservation targets and reserve networks is important but also the intersection of these with threats. In this respect and as we have previously seen, IAS are one of such threats. The ever-increasing number of alien species and the costs associated with them justifies the development of preventive risk management plans or strategies (Sandlund *et al.*, 1999; Pimentel *et al.*, 2005; Andreu and Vilà, 2010). These can be enhanced by the generation of risk maps of potential IAS spread, particularly so in protected areas, if they provide one of the main tools in biodiversity protection and safeguard native species from extinction. These risk maps are a necessary step towards effective management (Jiménez-Valverde *et al.*, 2011; Richardson and Whittaker, 2010) and resources should be focused where they will achieve the greatest benefit (van Wilgen *et al.*, 2011).

An important point to be taken into consideration when modelling IAS is that they may not have reached equilibrium in their new invaded environment, an important assumption in species distribution modelling (Václavík and Meentemeyer, 2009). IAS are normally not in equilibrium but in the process of expansion in a new environment and thus, extrapolation is needed (Kearney, 2006; Václavík and Meentemeyer, 2012). However, in certain areas where IAS have been established for an extended period of time, this equilibrium can be assumed (Williamson *et al.*, 2009; Gassó *et al.*, 2010) and SDM used safely in this respect.

1.5 Biodiversity Conservation Information Systems

Knowledge about biodiversity is paramount to its conservation; even more so if we take into account the pressing needs set by the ever increasing risk of biodiversity loss due to human action. In order to gain this knowledge, data at all levels is needed, both from the research and management domains: from genes to biomes and from local conservation actions to global ones. Two types of very specific and important data for conservation management and planning are species occurrence data and protected area boundaries.

Primary data on biodiversity has been captured over the decades in an unstructured, analog form: museum collections, scientific and technical literature, cartographical sheets, etc. Data such as taxon lists, species geographical atlases or protected area boundaries were compiled with a local, regional or national focus and each item represented at a single scale or resolution. There are vast quantities of them which need to be collected, organised and made accessible in order to be put to use in conservation research, management and planning. Biodiversity and protected areas information is needed in the research domain, and governmental organisations are required and recommended by competent bodies to make all this information public (European Environment Agency, 2007; Moritz *et al.*, 2011). Currently many different institutions around the world are in the process of digitising this information. Safeguarding them through databasing with georeferences and date stamps is critical (Boakes *et al.*, 2010).

In the last decades, there has been a huge increase in the availability of digitised information on biodiversity and protected areas in the form of GIS layers and geodatabases (Newbold, 2010). However, the simple translation from analogical to digital format is not sufficient. The relevant information they contain needs to be isolated and coded in some sort of structured format (database, xml, etc.) to make them readable by software agents. Georeferenced databases on the distribution of both protected areas and species is critically important, yet neither their structure nor their content is sufficient for the task of analyzing distributional patterns and coverage degree (Brooks *et al.*, 2004).

Since biodiversity data are complex, sophisticated information architectures are needed to handle them. With the advent of the digital revolution, we now have the tools to standardise, homogenise and aggregate this information. Current information and communication technologies offer an unprecedented opportunity to greatly enhance the handling, analysis and public dissemination of environmental information (Soberón and Peterson, 2004). Information systems are technological solutions aimed at solving the capture, storage, analysis and retrieval of data on a given knowledge field. Once in an information system, all sorts of outputs can be obtained from these data, *e.g.* simple queries, automated lists and reports, web mapping tools or species distribution maps derived from modelling tools. The combination of these needs and the current technological revolution has led to the emergence of the new field of biodiversity informatics, which deals with the application of information technologies to the management, algorithmic exploration, analysis and interpretation of primary data regarding life, particularly at the species level of organisation (Soberón and Peterson, 2004).

Handling biodiversity data for research or management purposes, even if in digital format, is a very time consuming task. Data needs to be prepared and organised for every task at hand. In order to make the most efficient use of researchers and managers time, access and analysis of these data needs to be made as agile as possible. This requires data in an integrated, coherent repository which obeys common standards such as common reference systems, controlled vocabularies, coding schemes and the like. In order to make the best use of both geographical and biological information, it must be captured in a standardised format to allow the union and intersection of both types of information (Reusser and Lee, 2011).

Not only homogenising and structuring the data is important but also the tools needed to exploit this information. Conservation Information Systems must deal with heterogeneous geographical and ecological data (alphanumerical attributes, vector and raster maps, documents, images, etc.) and information systems should provide the means to deal with all this kind of data in an integrated manner. It is necessary to hand researchers and managers comprehensive tools which allow to reach all these data from the same system, instead of via different software tools (da S. Torres *et al.*, 2006; Reusser and Lee, 2011). The pipeline between suppliers and users needs to be cleared. We need systems whereby data of different kinds, from many sources, can be combined (Scholes *et al.*, 2008).

A desired scenario of would be that of a centralized gateway to data repositories of worldwide information on species occurrences which can be queried for standardised well-structured metadata-enhanced datasets on any given species for any given region and time period. Modelling tools, software packages, would understand and accept some sort of agreed format on species occurrence data as input. This would free modellers from the tedious and time-consuming task of data compilation and preparation, freeing them to focus only with the problem at hand, saving countless hours of data management. This scenario has not been achieved yet. However, several initiatives are clearly going in that direction, the most prominent one being that of the Global Biodiversity Information Infrastructure or GBIF (GBIF, 2013a).

From the point of view of information access, unified repositories of data can be achieved by different means. A first obvious one is to design and develop a unique, central geodatabase containing all data coming from many different sources. This requires technical staff which has previously homogenised and integrated the information (an example of it would be the World Database on Protected Areas, see below). A second option would be that of a federated or virtual database where data can be accessed through a single data portal which retrieves information from different separate databases through a web services gateway (an example of it would be GBIF, see below). A distributed database is comprised of loosely coupled sites, connected over a computer network and hosted in separate computing facilities which may not even be in the same physical location. With this option, there needs to be a compromise on basic standards between the different institutions hosting the distributed databases so that the system can function properly. The hosting institutions may hold their data in very different systems but must agree to a given standard and web service of data interchange. In summary, the different systems must be interoperable, *i.e.* each system must be accessible by other systems without significant human and technical interaction (Masó, 2012). In this scenario, each institution is responsible for data stewardship and curation. In order to avoid dealing with the expensive task of collecting and organising information, a third option, far-fetched at the moment, would be needed. This would need artificially intelligent systems which can interpret unstructured and non-standardised information on their own and provide us with *digested* information. Meanwhile, the development of user-friendly, robust information systems is a must.

The need for readily available biodiversity information has been acknowledged at all levels, from local to regional, national and global institutions (governmental, non-governmental and international organisations) and there are innumerable initiatives (see Box 3 for some of the most relevant) at all these scales to collate such information in publicly available databases. Some leading international initiatives have become the leaders in terms of setting standards and in collecting and providing species and protected areas data: the Global Biodiversity Information Facility (GBIF) and the World Database on Protected Areas (WDPA), respectively.

BOX 3 - Examples of relevant Global Conservation Information Systems

GBIF	Global Biodiversity Information Facility (http://www.gbif.org)
WDPA	World Database on Protected Areas (http://www.wdpa.org)
EOL	Encyclopedia of Life (http://eol.org/)
BHL	Biodiversity Heritage Library (http://www.biodiversitylibrary.org/)
TOL	Tree of Life (http://tolweb.org/tree/)
FishNet	Global Network of Icthyology Collections (http://www.fishnet2.net/)
HerpNet	Global Network of Herpetological Collections (http://herpnet.org/)
ManIS	Mammal Networked Information System (http://manisnet.org/)
VertNet	Global Network of Vertebrate Collections (http://www.vertnet.org/)

Digital atlases of species' occurrences

Species occurrence data are compiled into digital species atlases, *i.e.* computerised databases of spatially-explicit species occurrences, normally in grid or raster format at different resolutions, coming from sources such as museum collections, herbaria and technical and scientific literature. These data are being compiled and made accessible over the Internet at an ever increasing speed (Soberón and Peterson, 2004). Since they come from disparate un-coordinated *ad-hoc* data sources they show numerous shortcomings which need to be addressed when used (see Section 1.2). Such challenges include the treatment of location and identification errors and of temporal and spatial bias. Maintenance and quality control of these databases is of high importance. Exponential technological change also poses a challenge for keeping these systems up-to-date and migrating them to new technological tools in order to prevent them from becoming locked in obsolete tools.

It is estimated that there are more species still to be discovered than those we already know, greatly varying among different groups of organisms; *e.g* while it is estimated that above 95% of mammals are already known, this number goes down below 5% in the case of nematodes (Scheffers *et al.*, 2012). Our knowledge is incomplete, taxonomy is still an evolving endeavour and phylogenetic trees are being refined continuously. Without an inventory list of the world s species, and still in the process of checking if every species is correctly classified, developing a spatially-enabled biodiversity database is a daunting challenge, yet unavoidable given the pressing conservation needs. Whatever knowledge we have needs to be put to use in conservation.

Among digital species atlases, GBIF stands out as the largest single gateway to species occurrence data which is global in scope (Yesson *et al.*, 2007).

Protected areas' databases

The part of the present dissertation which deals with information systems concentrates on protected areas databases. The importance of protected areas in preserving biodiversity and serving as a surrogate indicator of biodiversity makes the organisation of information on protected area boundaries in digital geodatabases a very important task for conservation evaluation. Besides being usable by itself, protected area boundaries can be combined with models of distributions of species of conservation interest to perform gap analysis and determine where conservation efforts should be placed (Scott *et al.*, 1993; Rodrigues *et al.*, 2004b; Langhammer *et al.*, 2007; United Nations Environmental Programme, 2008; Jantke *et al.*, 2011) and with models of distributions of IAS to determine the risk of invasion (Richardson and Whittaker, 2010). Advances in data availability and in the science of conservation planning enable us to act strategically in the face of increasing human pressure (Rodrigues *et al.*, 2004b). As is the case with biodiversity data, protected area boundaries need to be homogenised and integrated into geodatabases. This will ease its use in gap analysis and biodiversity protection assessments. In this respect, the World Database on Protected Areas (IUCN-UNEP, 2010) is the most comprehensive dataset on the world s terrestrial and marine protected areas. Other databases are only national or supra-national in scope, such as the Collaborative Australian Protected Area Database (Australian Department of the Environment, Water, Heritage and the Arts, 2008), the Protected Areas Database of the United States(GreenInfo Network, 2008) or the European Common Database on Designated Areas (European Environment Agency, 2009c), to cite the largest three.

An important but often neglected aspect on the information of protected areas boundaries is time. Protected areas are not static legal entities over time but undergo changes in their regulations which follow the legal and socioeconomic contexts at any given moment. These changes may not only affect the existing set of regulations but also their boundaries; i.e. they get extended, reduced, reclassified, amalgamated with neighbouring sites, renamed, etc. (Fish *et al.*, 2005). Having structured historical information on protected-area boundaries for all protection categories in a given territorial extent allows to monitor protected-area coverage over time and, thus, biodiversity protection. Also, it is possible to explore the social, economical and political factors driving changes in protected-area coverage and thus, hopefully, discover some hidden socioeconomic processes or drivers which govern how society decides whether to value and protect biodiversity.

1.6 Dissertation structure

This dissertation is structured as follows:

- Chapter 2 deals with the distribution modelling of rare species of conservation interest in order to obtain maps for assessing the degree of protection and extinction risk. Several narrowly distributed endemics of the Western Mediterranean have been used as an example.

- Chapter 3 explores how useful species distribution modelling tools are to generate fine-resolution maps from existing occurrence data in biodiversity atlases or databases. IAS are taken as an example for generating maps which can be useful as a conservation tool to prevent and mitigate IAS spread.

- Chapter 4 provides a design and implementation of an information system on protected areas which can handle historical changes in boundaries and help to monitor biodiversity protection over time. This information system has already been developed and deployed and is being used by the Catalan governmental stewards of this kind of information.

- Chapter 5. General discussion and conclusions.
- Appendices. Supplementary materials for the different chapters

Chapter 2

Using species distribution modelling to disentangle realized versus potential distributions for rare species conservation

In review in *Biological Conservation*

Arnald Marcer, Lluís Sáez, Roberto Molowny, Xavier Pons, Joan Pino

2.1 Abstract

Range maps provide important information in species conservation management, specially in the case of rare species of conservation interest. For the vast majority of cases, this information can only be estimated by means of species distribution modelling. When absence data is unavailable, modelled distribution maps represent the spatial variation of the degree of suitability for the species rather than their realized distribution. Although discerning potentially suitable areas for a given species is an important asset in conservation, it is necessary to estimate current distributions in order to preserve current populations. This work explores the use of species distribution modelling for species of conservation interest when their Extent of Occurrence (EOO) is well-known and there is quality occurrence data. In this case, derived binary maps of potentially suitable areas can be obtained and used to assess the conservation and protection status of a given species in combination with the EOO and existing protected area networks. Seven species which are rare and endemic to the Western Mediterranean have been used as an example. Valuable information for conservation assessment such as potentially suitable areas, EOO, Areas of Occupancy (AOO) and degree of protection is provided for this set of species. Also, the existing informal view among experts that these species have range sizes much smaller than their potentially suitable area is confirmed. This could probably be attributed to important currently unknown predictor variables and to historical phylogeographic factors.

Keywords

species of conservation interest, rare species, species distribution modelling, occupancy, range maps, Western Mediterranean

2.2 Introduction

A crucial aspect in the conservation of a species is the knowledge of the area it occupies. *i.e.* its range map and size. This kind of information is needed when evaluating its risk of extinction (Collar, 1996; IUCN, 2001; Rodrigues *et al.*, 2006) and when assessing its degree of protection (Scott *et al.*, 1993; Rodrigues *et al.*, 2004b,a). However, for the vast majority of species such information is either non-existent or very poor at any given scale (Newbold, 2010); this is known as the *Wallacean shortfall* (Lomolino *et al.*, 2004). This problem is aggravated when considering rare species, for which occurrence data tends to be very scarce. Collecting enough data from species surveys to delineate species ranges is an impractical and very expensive task (Niamir *et al.*, 2011). When no planned and systematic surveys exist, the only source of information available is presence-only data coming from opportunistic citations of species which can be found in the technical and scientific literature or in digital atlases compiled by public or private organizations (Anderson, 2012). Estimating the distribution of species by means of modelling tools becomes the only solution available when performing conservation assessments.

Studies abound which have successfully applied species distribution modelling techniques to existing species occurrence data in order to predict spatially-explicit species ranges even when data is scarce and presence-only (Elith *et al.*, 2006; Pearson *et al.*, 2007; Phillips and Dudík, 2008; Rebelo and Jones, 2010; Gogol-Prokurat, 2011; Razgour *et al.*, 2011). Species distribution modelling has been shown to be useful when modelling rare species with narrow ranges and available quality data (Sardà-Palomera *et al.*, 2012). Also, in the case of rare species, observations of occurrence normally represent a comprehensive view of their distribution and capture a large part of it (Lomba *et al.*, 2010).

In order to make decisions in conservation and protection of species, binary maps of presence/absence or suitable/unsuitable areas are much more preferred by conservation decision-makers than continuous probability models. A threshold value is needed to convert probability maps into these binary maps (Fielding and Bell, 1997; Liu *et al.*, 2005; Jiménez-Valverde and Lobo, 2007). These binary maps can then be used as species distributions and to calculate their range sizes and assess their conservation status and protection. Knowledge of species ranges is a necessary step to elaborate specific action plans for their conservation and ensure their inclusion in protected areas, two important conservation actions to ensure species survival (Cuttelod *et al.*, 2008). Extent of Occupancy (EOO) and Area of Occupancy (AOO) are accepted surrogate measures of species ranges used in assessing the extinction risk of species (IUCN, 2001). These are measures which try to reflect the species realized distribution. Yet, when no absence data is available, what we get are distributions close to potential ranges for the species (Jiménez-Valverde *et al.*, 2008; Lobo, 2008). Therefore, when using species distribution modelling techniques in conservation assessments, these differences between realized versus potential distributions need to be explicitly accounted for and explained.

Protected areas are one of the main conservation policy tools to address biodiversity protection, *i.e.* preserve species and ecosystems from human impact (Convention on Biological Diversity, 2010; Butchart *et al.*, 2012). Protected area coverage is used as a surrogate indicator or *proxy* of biodiversity conservation status (United Nations Environment Programme, 2009; United Nations Development Programme, 2009; United Nations Environment Programme, 2006; European Environment Agency, 2005; Millenium Ecosystem Assessment, 2005; Chape *et al.*, 2005). Normally, Protected areas are designated to protect species based on existing current known distributions, not potentially suitable areas. It has been found that protected area systems are highly inefficient since they do not always cover key species (Jackson *et al.*, 2009). Also, knowledge of the discrepancy between realized and potential distributions can contribute not only to assess conservation and protection status (Attorre *et al.*, 2012) but also to identify possible areas for the translocation of species.

The Mediterranean Basin is a threatened biodiversity hotspot with a high human population density (Cincotta *et al.*, 2000; Myers *et al.*, 2000; Underwood *et al.*, 2009) which drives important processes of land use change, habitat fragmentation and habitat loss, specially in coastal areas (Vogiatzakis *et al.*, 2005; Gerard *et al.*, 2010). It is a region of high conservation risk where there is an important disparity between habitat loss and protection (Hoekstra *et al.*, 2005). It is one of the world s most diverse regions with respect to plants (Cowling *et al.*, 1996; Médail and Verlaque, 1997; Médail and Quézel, 1999). Its exceptional number of endemic plants (13000 out of an estimated total of 25000), representing 4.3% of all plant species globally, make it a *hyper-hot* candidate for conservation support (Mittermeier *et al.*, 1998; Myers *et al.*, 2000; Olson and Dinerstein, 2002) even more so when considering that over 1900 of them are threatened or extinct (Brooks *et al.*, 2002). Endemic species have restricted geographic ranges and are prone to become endangered and at risk of extinction, an even higher risk when they are also rare. Knowledge of endemic plant distributions is much needed in the Mediterranean Basin (Kark *et al.*, 2009). Despite the existence of an extensive protected area network, particularly in the European side, there is little knowledge of the amount of suitable and actual ranges of species of protection interest that fall into protected areas. In addition, endemisms are a specially significant case for which the determination of those ranges is of outmost importance. Conservation actions should ensure that species currently listed as threatened are sufficiently protected (Margules and Pressey, 2000; Underwood *et al.*, 2009).

The purpose of this paper is threefold: a) to develop a methodology for assessing range sizes and conservation status of rare species, b) to explore the discrepancy between realized and potential ranges when using species distribution modelling with presence-only data and finally, c) to estimate range sizes for seven case-study western Mediterranean endemisms of conservation interest.

2.3 Methods

Area of study

The study area is the Western Mediterranean as defined by those areas of Mediterranean climate inside the bounding box with the following coordinates: west=2300000 m, south=930000 m, east=5100000 m and north=2600000 m (Lambert Azimuthal Equal Area (LAEA))(see 2.1). We defined Mediterranean climate zones by a broadly drawn polygon comprising categories csa , csb and csc in Koppen-Geiger climate classification (Kottek *et al.*, 2006). The study area has been limited to the Western Mediterranean and not the whole basin since none of the study plants has ever been found east of Italy. The extent of the study area used when modelling the distribution of species needs careful consideration since it has important consequences in the outcome of the model (Sardà-Palomera *et al.*, 2012); *e.g.* increasing its area increases the AUC values (Jiménez-Valverde *et al.*, 2008). The appropriate extent of analysis should correspond to those areas that have been accessible by the species over relevant periods of time (Barve *et al.*, 2011); *i.e.* region M in a BAM diagram (Soberón and Peterson, 2005; Soberón and Nakamura, 2009). Our study area comprises most of the Iberian peninsula, southern France, western and southern Italy, two thirds of northern Morocco, northern Algeria and northern Tunisia. All data in this study has been projected to LAEA-ETRS89 and used at this coordinate system.

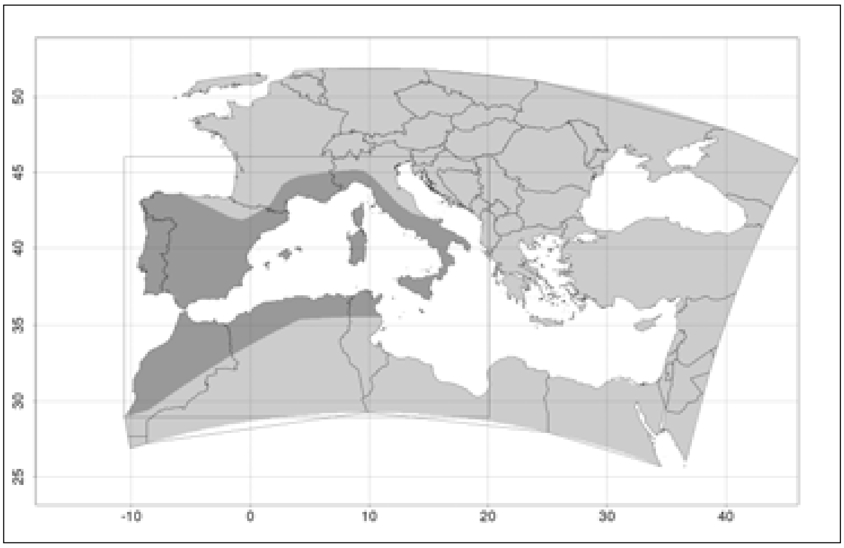


Figure 2.1: Study area corresponds to the dark grey area on the map. This area represents the mediterranean climate region within the western mediterranean bounding box (west=-10.573961, south=28.930152, east=21.237540, north=51.369878 (WGS 84 EPSG:4326)). It represents our assumed M area, as in (Soberón and Peterson, 2005)

Data

Species data Table 2.1 lists the seven vascular plant species considered in this study (endemic to the Western Mediterranean). These species have been selected with the criteria of a) being endemic to the Western Mediterranean, b) having quality occurrence data available at 1 km resolution with a minimum of 10 occurrence points per species, c) being taxonomically unambiguous at the species level and without separate subspecies at different locations in the study area, and d) being of scientific interest due to the disagreement between their known ranges and their apparently potential available areas. All are restricted to the middle eastern coast of the Iberian Peninsula and the Balearic Islands except for *Euphorbia squamigera* Loisel. and *Helianthemum caput-felis* Boiss. which have also been cited in the north of Africa (see Figures 2.2 and 2.3). Occurrence records have been compiled from multiple sources (scientific papers, monographs and *herbaria* records) and are considered quality records; *i.e.* it can be safely assumed that they have been correctly identified and georeferenced. This will be an important point to take into account when selecting a threshold to obtain binary maps from the models (see below).

Table 2.1: Study species. Column *n occ.* is the number of occurrences available per species at 1000 m resolution

Species	**n occ.**
Asplenium majoricum Litard.	19
Carduncellus dianius (Webb) G. López	24
Diplotaxis ibicensis (Pau) Gómez Campo	72
Euphorbia squamigera Loisel.	52
Helianthemum caput-felis Boiss.	50
Medicago citrina (Font Quer) Greuter	10
Silene hifacensis Rouy ex Willk.	25

Environmental predictors We used the set of 19 bioclimatic variables which represent a combination of annual trends, seasonality and extreme conditions relevant to species physiological tolerances (Nix, 1986). We added two more variables: distance to the coast (these plants are clearly distributed along the coast) and soil pH (presence of these plants seems to be clearly associated with soil pH) (see table 2). Bioclimatic variables were obtained from the WorldClim database (Hijmans *et al.*, 2005). pH was prepared by completing the information provided by the European Soil Database (European Soil Data Centre, 2012) with information provided by the Harmonized World Soil Database (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012) for the North of Africa. Distance to the coast was computed using boundaries extracted from GADM database of Global Administrative Areas (http://www.gadm.org). Since the aim of this study is not explanatory but predictive and since collinearity does not seem to affect predictive performance when using Maxent (Kuemmerle *et al.*, 2010), all predictors were kept when modelling and no collinearity analysis between predictors was done. All environmental predictors were prepared in the ETRS89 / ETRS-LAEA coordinate system (EPSG:3035) at 1000 m resolution.

Solving resolution issues These endemic species have restricted narrow coastal ranges, which means that some records are very close to the coastline. Due to resolution issues, some of these records may fall in no-data pixels of the environmental set of predictors, that is, they are sea-pixels in the predictors layers. For each predictor variable we assigned the value of their closest neighbour to these no-data pixels or the mean value if more than one neighbour was present. This allowed us to keep all occurrence records for modelling, instead of having to discard valid occurrence points from already scarce data.

Species distribution modelling

Modelling approach Occurrence records for these rare endemics are presence-only and scarce. Techniques for dealing with such conditions have been developed in the last few years. One of such techniques is maximum entropy modelling (Maxent), which has

Table 2.2: Set of environmental predictors used. All predictors were projected to ETRS89 / ETRS-LAEA (EPSG: 3035) coordinate system

Bioclimatic variables
Annual mean temperature
Minimum temperature of the coldest month
Mean temperature of the coldest year quarter
Mean temperature of the warmest year quarter
Mean temperature of the wettest year quarter
Mean temperature of the driest year quarter
Maximum temperature of the warmest month
Annual mean precipitation
Precipitation of the coldest year quarter
Precipitation of the driest month
Precipitation of the driest year quarter
Precipitation of the warmest year quarter
Precipitation of the wettest month
Precipitation of the wettest year quarter
Annual temperature range
Mean temperature diurnal range
Isothermality
Temperature seasonality
Precipitation seasonality
Mean solar radiation of the least radiated quarter
Mean solar radiation of the most radiated quarter
Soil variables
pH
Physical variables
Distance to coast

been proved valid in conservation assessment for modelling species distributions with scarce presence-only data (Phillips *et al.*, 2006; Elith *et al.*, 2006; Pearson *et al.*, 2007; Elith *et al.*, 2011; Rebelo and Jones, 2010). We used Maxent software (version 3.3.3k, http://www.cs.princeton.edu/ schapire/maxent/). MaxEnt estimates the distribution of maximum entropy constrained in such a way that expected values for predictor variables match their empirical average. Its logistic output can be interpreted as the relative environmental suitability of each pixel in relation to the background of the study area (Phillips *et al.*, 2006; Phillips and Dudík, 2008). Models were run using the default set of parameters of the software and using the whole set of environmental predictors (Table 3.2).

Dealing with spatial autocorrelation Spatial autocorrelation (SAC) needs to be taken into account in order to avoid inflation of accuracy measures (Veloz, 2009). We used a preventive approach to SAC avoidance by preparing several a priori autocorrelation treatments as in Marcer *et al.* (2012). For each species, we prepared four different sets of records corresponding to minimum euclidean distances (1500m, 3000m, 4500m, 6000m), five sets corresponding to minimum environmental distances according to the Gower metric (Gower, 1971) (0.025, 0.050, 0.75, 0.1, 0.125) and one set with all occurrence records. Residual SAC (observed occurrence minus probability of occurrence) was then measured as in De Marco Jr *et al.* (2008); Nunez and Medley (2011); Václavík and Meentemeyer (2012); Marcer *et al.* (2012) using Monte-Carlo simulation of Moran s I autocorrelation coefficient using package spdep in R (Bivand *et al.*, 2011). All models with significant residual SAC were discarded (25 out of 70).

Model evaluation and selection We validated the remaining 45 models by partly following the methodology described in Pearson *et al.* (2007). When the number of occurrences was low (in our case, < 25) it was feasible to calculate the 2^N possible D statistics (as proposed by Pearson *et al.* (2007)). In these cases, we used the software prepared by those authors and which they made available as supplementary information in their work. On the other hand, for higher number of occurrences we designed an alternative test. We split the number of occurrences, N, into M groups with the an equal number of elements, $\frac{N}{M}$. Although this approach does not work when N is a prime number, there was no such case. Next, we implemented a jackknife leave-$\frac{N}{M}$-out procedure whereby M occurrence maps were computed with the Maxent algorithm by leaving $\frac{N}{M}$ occurrence data points out each time. We defined the test criterion D^* simply as the sum of all successes, where success for each map was defined as the number of points that were correctly predicted:

$$D^* = \sum_{i=1}^{M} x_i \text{ where } x \quad 0, ..., \tfrac{N}{M}$$

Notice that, in this case, we abandoned the weighting strategy of Pearson *et al.* (2007) for the sake of simplification. All possible simulated D^* values were calculated by assuming that each x_i could take on any value between 0 and $\frac{N}{M}$ and we checked whether $D^*_{simulated} \geq D^*_{observed}$. When this inequality was true we added the probability of obtaining the simulated D^* value as defined by:

$$P = \prod_{i=1}^{M} B(x_i, \tfrac{N}{M}, p_i)$$

where B is the probability mass function of a binomially distributed random variable and p_i is the proportion of the study area that was predicted by the corresponding map, as in Pearson *et al.* (2007). For the sake of comparison between our proposed methodology and that of Pearson *et al.* (2007) we calculated the D* index and its associated probability for one species and for all possible number of groups M, and verified whether all resulting probabilities were similar.

Of all accepted models and for each species, we chose the model with the highest success rate when considering all test points from all cross-validation folds; *i.e.* number of correctly classified test points divided by the total number of test points. See Table 2.3 (we used a threshold-dependent validation, test AUC of Maxent is only given for informative purposes). Finally, we run again the chosen models with the whole set of occurrences to obtain the final suitability map. Maps of these models can be found in Appendix A.

Geographic range

Potential range maps can be derived from species distribution models by applying a cut-off threshold value to determine suitable and unsuitable areas. EOO and AOO are both valid measures of range size under IUCN criteria for the red listing of species. EOO is the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy while AOO is the area within its extent of occurrence which is occupied by a taxon, excluding cases of vagrancy (IUCN, 2001). Measures of overall potential range area, EOO and AOO are given in Table 2.4.

Extent of occurrence (EOO) For each species, EOO was computed as the area resulting from applying the convex hull method (package dismo in R; Hijmans *et al.* (2012)) to all available occurrence points for each species. The area occupied by clearly unsuitable habitat (in our case, the sea) inside the hull was subtracted from the total. This method is acknowledged by IUCN as a valid measure of the EOO (IUCN, 2001).

Threshold selection In order to calculate AOO we need binary maps which can be obtained from continuous probability models by setting a threshold value above which the location is considered suitable. Since our occurrence data are accurate and reliable (for correct species identification and georeferencing) we used the MTP (Minimum Training Presence) value as threshold. MTP is the logistic threshold that results in inclusion of all training presences. This also ensures a zero omission rate, which is a desired outcome when trying to define suitable areas for species of conservation interest with limited ranges. Also, MTP can easily be argued ecologically since it includes all sites that are at least as suitable as those where the species has been recorded as present (Pearson *et al.*, 2007). Since our aim is to calculate the suitable area for the species, the inclusion of all areas with a probability value above MTP seems a sensible decision. We converted the chosen models (Table 3) into binary maps by setting all values below MTP as zero and all values equal or above MTP as one (see Appendix A and B).

Area of occupancy We used R (R Core Team, 2012) packages raster (Hijmans and van Etten, 2012) and dismo (Hijmans *et al.*, 2012) to calculate the total suitable area of the species (we refer to it as PSA (Potentially Suitable Area)) and the Area of Occupancy (AOO) defined as the PSA within the EOO (Extent of Occurrence). All areas were calculated at 1000 m resolution but, for AOO, we also calculated it at 2000 m resolution in order to follow the guidelines given by IUCN (IUCN Standards and Petitions Subcomittee,

2011) for assessing the conservation status of a species.

Assessing the protection status of species

We prepared a raster layer of protected sites by combining information from Natura 2000 boundaries (European Environment Agency, http://www.eea.europa.eu) for the European part of our study area with information from the World Database on Protected Areas (IUCN and UNEP, 2009) for the African part of it. The protection layer was obtained at 100 m resolution. We changed the resolution of our binary maps of suitability/unsuitability to match the resolution of the protected areas layer. Then, we calculated the percentage of 100 m cells of PSA, EOO and AOO that were covered by protected areas as provided in Table 2.5. In the table shown, an indication of the conservation status of each species according to criteria B1 and B2 of IUCN is given (IUCN Standards and Petitions Subcomittee, 2011).

2.4 Results

Distribution models and range maps for seven narrow-range endemic plant species of the western Mediterranean have been provided (see Figure 2.2, Figure 2.3 and Appendix A. For these species, the authors only have evidence of a former study on *Helianthemum caput-felis* (Zaragozí *et al.*, 2012) dealing only with the analysis of open source software for AOO calculation. Table 2.3 shows the best models per species (a figure for each model is available in Appendix A). Except for *Medicago citrina*, all species needed some sort of SAC treatment (two euclidean and four environmental) which implied losing some occurrences for modelling (2.4). After SAC treatment, occurrence records diminished from as low as 42% for *Euphorbia squamigera* to as high as 64% for *Silene hifacensis*. Occurrence records available for modelling ranged from as low as 9 (*Asplenium majoricum* and *Silene hifacensis*) up to 40 (*Diplotaxis ibicensis*). Success rates for classification of test points were very high, ranging from 0.889 (*Asplenium majoricum* and *Silene hifacensis*) to 0.975 (*Diplotaxis ibicensis*). Test AUC is provided only for informative purposes and ranges from 0.968 to 0.999.

We tested how the proposed D* described above, which we applied when the number of cases was ≥ 25, performed when compared to the methodology in Pearson *et al.* (2007). We computed D* for the *Helianthemum caput-felis* dataset (24 cases, see Table 3) for M=2, 4, 6 and 8 groups. The corresponding probability p was in all cases larger than the case where M=24, although always very small and significative. That is, D* performs in our test more conservatively than the original D in Pearson *et al.* (2007), although the differences are always very small and negligible within the context of our study.

Table 2.3: A list of the finally chosen models selected by having the highest *success rate*, alphabetically ordered. Column *Test AUC* is given only for informative purposes. Column *SAC treatment* indicates which of the corresponding treatments led to the finally chosen model. Column *Nr. occ.* indicates the number of occurrences used per species. Column MTP is the Minimum Training Presence threshold used when generating the binary maps

Species	**Nr. occ.**	**SAC treatment**	**Success rate**	**Test AUC**	**MTP**
Asplenium majoricum	9	gower (0.125)	0.889	0.968	0.2982
Carduncellus dianius	11	euclidean (1500 m)	0.909	0.998	0.2185
Diplotaxis ibicensis	40	gower (0.025)	0.975	0.998	0.0764
Euphorbia squamigera	30	gower (0.075)	0.933	0.882	0.2131
Helianthemum caput-felis	24	gower (0.025)	0.917	0.997	0.1543
Medicago citrina	10	none	0.900	0.999	0.5829
Silene hifacensis	9	euclidean (4500 m)	0.889	0.997	0.3799

Table 2.4 shows the PSA, EOO, AOO calculated at 1000 m resolution, AOO calculated at 2000 m resolution and the corresponding proportions of EOO with respect to PSA and AOO with respect to both PSA and EOO. These proportions serve as an index of how close the species distribution is to its potential range and to its extent of occurrence. This can be seen in Figures 2.2 and 2.3. *Euphorbia squamigera* appears to be the species which uses more of its potential range (71.3%) and *Carduncellus dianius* is the one which is more narrowly distributed in relation to its PSA (only 3.0% of its PSA is EOO). As for the relation of AOO to EOO, three species (*Asplenium majoricum*, *Carduncellus dianius* and *Silene hifacensis*) have a suitable area of 88% or more of their EOO, three of them (*Diplotaxis ibicensis*, *Helianthemum caput-felis* and *Medicago citrina*) appear to have

their suitable areas sparsely distributed within their EOO and in one case, *Euphorbia squamigera*, slightly more than half its AOO is EOO.

Table 2.4: Species ranges in square kilometers. Columns: PSA (Potentially Suitable Area as determined by MTP threshold), EOO (Extent of Occupancy), AOO_{1k} (Area of Occupancy calculated at 1000 m resolution), AOO_{2k} (Area of Occupancy calculated at 2000 m resolution), EOO/PSA (Proportion of EOO in relation to PSA), AOO/PSA (Proportion of AOO in relation to PSA), AOO/EOO (Proportion of AOO in relation to EOO)

Species	**PSA**	**EOO**	**AOO$_{1k}$**	**AOO$_{2k}$**	**EOO/PSA**	**AOO/PSA**	**AOO/E00**
Asplenium majoricum	56706	6695	6566	7132	0.118	0.116	0.981
Carduncellus dianius	9227	280	268	348	0.030	0.029	0.957
Diplotaxis ibicensis	5250	3005	1044	1488	0.572	0.199	0.347
Euphorbia squamigera	325269	231977	135646	143428	0.713	0.417	0.585
Helianthemum caput-felis	11195	2039	927	1484	0.182	0.083	0.455
Medicago citrina	973	586	137	268	0.602	0.141	0.234
Silene hifacensis	2365	215	190	284	0.091	0.080	0.884

Table 2.5 shows the percentages of PSA, EOO and AOO which are protected by the current existing protected areas and an evaluation of the conservation status of the seven species according to IUCN s criterion B (Geographic range size and fragmentation, decline or fluctuations) (IUCN Standards and Petitions Subcomittee, 2011). B1 is based on EOO and B2 is based on AOO. Fragmentation, decline or fluctuations have not been evaluated in this study. This study provides information for a first assessment of conservation status for four species not yet evaluated by IUCN (IUCN, 2012): *Asplenium majoricum*, *Carduncellus dianius*, *Euphorbia squamigera* and *Helianthemum caput-felis*. It is important to note that in order to qualify for criterion B, meeting the requirements for EOO and AOO is not sufficient since information on fragmentation, decline and fluctuation is also necessary. Thus, the information contributed by this study only regards to geographical range, that is EOO and AOO.

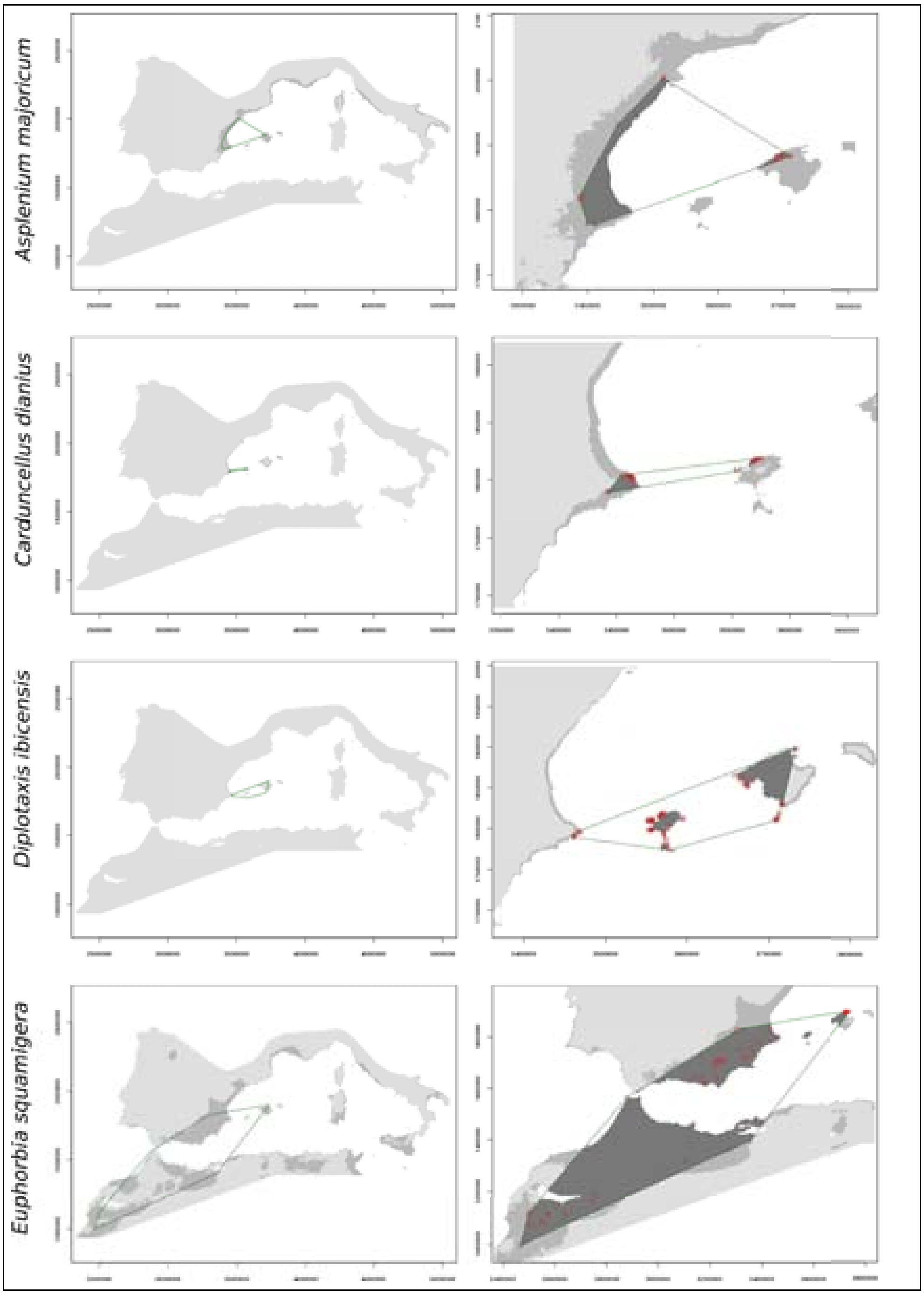


Figure 2.2: For four of the study species, a general overview map (left column) and close-up (right column) of the Extent of Occurrence. In both columns, the green lines represent the polygon corresponding to the Extent of Occurrence (EOO). In the left column, the dark grey zones represent the Potentially Suitable Area (PSA). In the right column, the darkest grey zones represent the Area of Occupancy (AOO), that is, the PSA within EOO

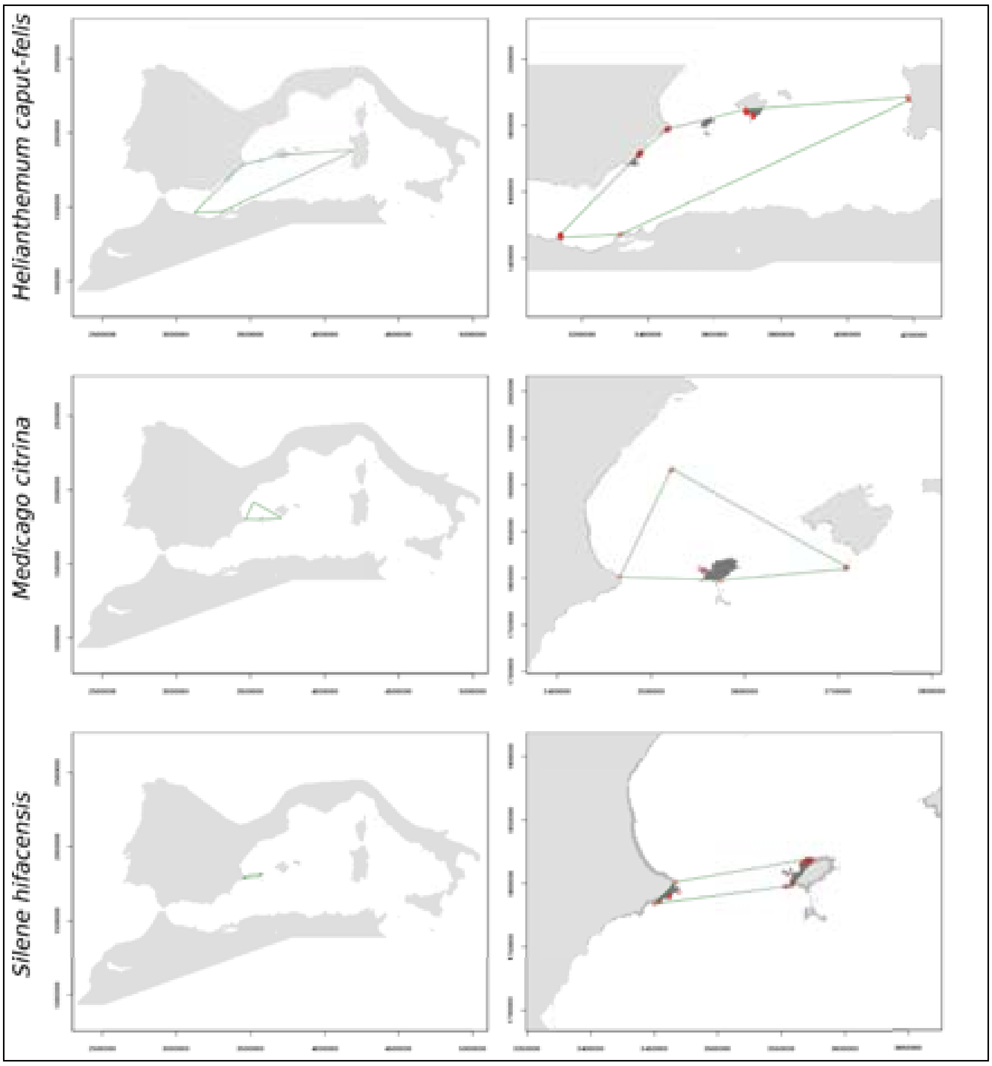


Figure 2.3: *Idem* as Figure 2.2

Suitability and protection maps showing spatially explicit protection for each species PSA, EOO and AOO as well as an extensive evaluation of the protection of PSA, EOO and AOO given by each specific protected area are available in Appendixes B and C.

2.5 Discussion

The approach to obtain models, range maps and range sizes used in this study makes a methodological contribution to the conservation assessment of rare species in the line of Attorre *et al.* (2012). In biogeography studies and conservation management, both

Table 2.5: Species conservation status and protection. Column PSA_{PR} indicates the percentage of PSA that is protected, column EOO_{PR} indicates the percentage of EOO that is protected and AOO_{PR} the percentage of AOO that is protected. Columns $IUCN_{B1}$ and $IUCN_{B2}$ indicate the evaluation made by this study for each species according to the range part of criteria B1 (CR: <100 km^2, EN: <5000 km^2, VU: <20000 km^2) and B2 (CR: <10 km^2, EN: <500 km^2, VU: <2000 km^2) of IUCN. Column $IUCN_{CUR}$ indicates the current IUCN assessment (IUCN, 2012). IUCN categories: CR (Critically Endangered), EN (Endangered), VU (Vulnerable), LC (Least Concern), NE (Not Evaluated))

Species	**PSA**$_{PR}$	**EOO**$_{PR}$	**AOO**$_{PR}$	**IUCN**$_{B1}$	**IUCN**$_{B2}$	**IUCN**$_{CUR}$
Asplenium majoricum	24.6	22.2	22.4	VU	LC	NE
Carduncellus dianius	22.8	17.9	17.9	EN	EN	NE
Diplotaxis ibicensis	23.9	18.4	22.2	EN	VU	LC
Euphorbia squamigera	19.9	13.0	18.9	LC	LC	NE
Helianthemum caput-felis	20.3	14.6	27.6	EN	VU	NE
Medicago citrina	27.9	15.3	24.9	EN	EN	CR
Silene hifacensis	27.5	22.5	22.9	EN	EN	EN

realized and potential distributions are of much interest realized distributions to ensure conservation and potential distributions as candidate areas for relocation or for discovering unknown populations (Wilson *et al.*, 2011; Thorn *et al.*, 2009; Peterson *et al.*, 2011).

It is necessary to explicitly distinguish between realized and potential distributions when modelling species distributions since different methods and data will lead to diferent outcomes. Both presences and absences are necessary when modelling realized distributions (Jiménez-Valverde *et al.*, 2008; Soberón and Nakamura, 2009; Jiménez-Valverde, 2012). Absence data, specially when considering coarse grid data, is very hard to obtain and justify since absences may be of false origin, *i.e.* the species is present but has not been observed (Gu and Swihart, 2004). In our case, only presence data is available and the outcome of our model should be considered as PSA. The studied species represent a set of rare species of high conservation interest in a well-surveyed zone for vascular plants at 1000 m resolution. According to experts, for these species, it can be safely assumed that their occurrence points closely approximate their extent of occurrence (EOO); *i.e* though not impossible, it is unlikely that new occurrences will be found outside their current EOO. Therefore, the PSA which falls inside the EOO can be considered a good approximation to the AOO of the species.

In the case of rare species in well-surveyed areas where their EOO is well-known, the models resulting from species distribution modelling can be interpreted in terms of realized and potential distributions. With presence-only data, the potentially suitable area within EOO is the best approximation we can have to a realized distribution or AOO. Moreover, when the purpose of these modelling exercises is to generate valuable information for conservation efforts the selection of the MTP threshold is an adequate one to generate binary maps of suitability/unsuitability (Pearson *et al.*, 2007). Therefore, in these circumstances, the knowledge gained from the modelled current and potential distribution of the species can be used to assess the conservation of the species by generating maps and reports of their protection status (see Supplementary Materials).

Conservation can t afford to wait until enough information is available for a given species since we may end up losing the species in the process. It thus becomes necessary to make the best informed decisions possible at any given moment. Combining expert judgement with modelling tools can be the best solution at hand. Using this approach, we have provided valuable conservation and protection assessment status for these seven species. This protocol can t be considered definitive but it can be repeated as new occurrence data becomes available, specially so in the unlikely case that it enlarges the current known EOO of the species. One can envisage an information system which uses this protocol and provides up-to-date conservation assessments for rare species where the PSA, EOO and AOO are automatically updated.

The species in our study were also selected because they puzzled botanists due to the fact that their EOO seems very restricted if one considers the apparently available suitable area that they have at their disposal, *i.e. Grinnellian* niche. This study contributes to confirming and highlighting this fact as can be seen in Table 2.4. The models do show a much wider suitable area for each of the seven species than the area they actually occupy. Except for *Asplenium majoricum* whose dispersion is by anemocory, the other six species are dispersed by barochory alone (*Medicago citrina* shows zoocory to a lesser degree). For these six species, one can argue that their restricted current range compared to their available suitable area is due to historical phylogeographical reasons as well as to their form of dispersal. For *Asplenium majoricum* this argument does not hold and we should point to other reasons such as the use of an excessively restricted set of predictor variables. It may be argued that, except for *Asplenium majoricum*, the area where the species has had historical access because of its movement and colonizing capacities, the M region as in Soberón and Peterson (2005) and Soberón and Nakamura (2009), appears to be their current extent of occurrence. If so, given that some authors argue that the extent of analysis should correspond to those areas that have been accessible by the species over relevant periods of time (Barve *et al.*, 2011), further modelling efforts might be made using only their EOO or a slightly buffered EOO.

For the particular case of *Euphorbia squamigera*, our model shows a high suitability index in the Provence zone in France, outside the estimated EOO. It is interesting to note that the first description of this species was done in the area of Toulon (Loiseleur-Deslongchamps, 1807). However, apart from this first citation, the plant has not been found again, which has always made botanists doubt about it in the first place (this is the reason why we have excluded this presence in our modelling occurrence data) and think this may be a case of misidentification. Our results lend support for the correctness of this first citation. If it were to be confirmed, this citation would add to the validity of the PSA obtained from the models although the EOO and AOO would need to be recalculated. This also reinforces the fact that these models show PSA rather than realized distributions. The set of predictor variables used in this study, combined with the lack of absences in our modelling technique, is not sufficient to restrict the output distribution to the realized distribution.

Table 2.4 shows the absolute values found in this study for each species PSA, EOO and AOO. Interestingly, the EOO of *Asplenium majoricum*, which is dispersed by anemocory, represents only about 12% of the available PSA. As stated above, this could be explained by the lack of appropriate predictor variables in this study. On the other hand, its EOO is almost covered by its AOO, which can be explained by its dispersal form. However, more hidden factors seem to play an important role in its distribution since very few occurrences are available for this area. For the remaining species, which are dispersed by barocory, there is a wide span of values of the relation AOO/EOO, from 23.4% to 95.7%. Contrary to the case of *Asplenium majoricum* one would expect these values to be low due to their form of dispersal. Here, there are also hidden factors at play which are outside the scope of this study, although it does not seem to be the case at present, predation may have played its role historically.

Species distribution modelling for rare species in well-surveyed areas can provide a good approximation to species realized and potential distributions. These distributions can be overlaid with the network of protected areas and give valid assessments of conservation status and protection. Table 2.5 provides an assessment of the protection given by current protected areas to each species PSA, EOO and AOO and valuable information for the classification of each species according to IUCN categories of threatened species (IUCN Standards and Petitions Subcomittee, 2011). From a conservation management perspective, the protected percentage of EOO and AOO can give an indication of how well-covered the range of the species is by protected areas. Also, the information regarding the presence of part of the species PSA in each protected area can be of great use should relocation efforts be considered for enlarging the current EOO and thus, add to the probability of the species persistence (a comprehensive list of the protected areas that contain part of each species PSA is given in Appendix C).

2.6 Conclusions

Species distribution modelling is a valid tool for generating valuable information for conservation management when dealing with rare species in well-surveyed areas. The use of well-known EOOs of species with modelled maps of suitability offers a way to discern between an approximation of realized and potential distributions. This paper provides probability models and range maps for seven rare endemic vascular plants of the western Mediterranean for the first time and a first quantitative assessment of their realized and potential distributional areas, their degree of protection and information useful to assess their degree of threat.

Except for one case, the PSAs for the set of studied species are much larger than their corresponding EOOs. This confirms the previously existing expert view which was unsupported by data that these species are much more restricted in range than the area that appears to be suitable for them. Although not explored in this study, this is probably due to a combination of historical phylogeographical reasons and to the absence of some environmental or biotic predictors which could contribute to determine the species spatial distribution.

2.7 Acknowledgements

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Chapter 3

Modelling invasive alien species distributions from digital biodiversity atlases. Methodological insights for reconciling data at different scales

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3.1 Abstract

Aim There is a wealth of information on species occurrences in biodiversity data banks, albeit presence-only, biased and scarce at the fine resolutions. Moreover, in biodiversity conservation fine-resolution species maps are in need. New techniques for dealing with this kind of data have been reported to perform well. However, when good coarser scale data are available, are these fine-resolution maps robust enough to also explain coarser distributions ? We present a new methodology for testing this hypothesis and apply it to invasive alien species (IAS).

Location Catalonia, Spain.

Methods We used species presence records from the Biodiversity data bank of Catalonia to model the distribution of ten IAS which, according to some recent studies, achieve their maximum distribution in the study area. To overcome problems inherent with the data, we prepared different correction treatments: three for dealing with bias and five for autocorrelation. We used the MaxEnt algorithm to generate models at 1 km resolution for each species and treatment. Acceptable models were upscaled to 10 km and validated against independent 10 km occurrence data.

Results Out of a total of 150 models, 20 gave acceptable results at 1 km resolution and 12 passed the cross-scale validation test. No apparent pattern emerged which could serve as a guide on modelling. Only four species gave models that also explained the distribution at the coarser scale.

Main conclusions Although some techniques may apparently deliver good distributions maps for species with scarce and biased data, they need to be taken with caution. When good independent data at a coarser scale are available, cross-scale validation can help producing more reliable and robust maps. When no independent data are available for validation, however, new data gathering field surveys may be the only option if reliable fine-scale resolution maps are needed.

Keywords Invasive alien species, atlas, biodiversity databases, Catalonia, cross-scale validation, maxent, Spain, species distribution models

3.2 Introduction

For centuries, species occurrences have been recorded in an *ad hoc* way by natural historians, museums, scientists and the like in the form of museum specimens, site inventories, citations in technical and scientific literature, etc. (Chapman and Busby, 1994; Chapman, 2005b). In the last two to three decades, both governments and non-governmental organizations have invested considerable financial resources on the digitizing of these data into digital species distribution atlases and making them publicly available. Ideally, they should offer reliable, high quality data which withstands public, scientific and legal scrutiny (Robertson *et al.*, 2010). Such databases represent a wealth of information on species distribution and an indispensable asset for science and conservation (Funk and Richardson, 2002; Graham *et al.*, 2004; Suarez and Tsutsui, 2004; Franklin, 2009; Robertson *et al.*, 2010). However, since these data usually come from opportunistic or *ad hoc* sources rather than well-planned surveys, they present some important drawbacks: they are presence-only in nature, are highly biased and may show spatial agregation derived from sampling biases. Also, since they are laborously compiled from analog sources, they are difficult and costly to georeference and hence, coarser resolutions tend to dominate (Margules and Pressey, 2000; Pressey, 2004). As a result, most data in this kind of biodiversity databases are often too coarse for use in conservation planning and management, where fine grained maps (*i.e.* 1 km or better) are needed (McPherson *et al.*, 2006; Guralnick and Hill, 2009; Niamir *et al.*, 2011).

Planned systematic surveys of species presence and abundance could provide the most precise, accurate and unbiased information on the spatial distribution of biodiversity. However, such surveys are expensive to conduct for large regions, even for a single species (Robertson *et al.*, 2010). Given the current accelerated trend in world-wide biodiversity loss and the urge for addressing conservation problems, it becomes of utmost importance to find ways and methodologies to make the best use of this already available information (Newbold, 2010; Venette *et al.*, 2010).

Such databases or atlases of species occurrences still represent a largely untapped potential of information which can play an important role in conservation biogeography (Richardson and Whittaker, 2010). Fortunately, in the last few years the community of species distribution modelling has witnessed the appearance of new tools and methodologies from the fields of statistics and artificial intelligence which have the potential to address the problems inherent in these data. Some of these tools have been specially tailored to model presence-only data even when only few occurrences are available and problems such as bias and autocorrelation are present. One of such techniques, maximum entropy, has been judged among the best performers in distribution modelling for such kind of data (Elith *et al.*, 2006).

In many cases, applying these novel techniques to the scarce fine-resolution data can yield distribution maps with high validation scores. The question is whether we can take advantage of coarser data, which are relatively abundant and for some regions close to the species true distribution, to further validate these maps and find out their reliability. Having models that explain data at fine resolutions while being consistent with coarser resolution data is important (McPherson *et al.*, 2006; Niamir *et al.*, 2011) as it can yield more robust and reliable distribution maps for conservation.

The existence of databases with such information provides an opportunity to check this hypothesis. A specially relevant piece of information for conservation which can potentially be derived from these costly data banks are current and historical distributions of Invasive Alien Species (IAS).

The spread of IAS, driven mainly by human activities, is increasing worldwide (Butchart *et al.*, 2010) and pose potential problems not only to native biodiversity but also to economic development and human well-being (Vitousek *et al.*, 1997; Taylor and Irwin, 2004; Pimentel *et al.*, 2005; Chytrý *et al.*, 2009; Pejchar and Mooney, 2009; Pyšek *et al.*, 2010; Vilà *et al.*, 2011). Having risk maps representing the potential distribution of IAS is a necessary step towards effective management (Richardson and Whittaker, 2010; Jiménez-Valverde *et al.*, 2011). Using all information in species inventories and atlases, coarse and fine resolution records, is essential in making the most out of limited financial resources (Nielsen *et al.*, 2008).

We test whether fine-resolution maps of IAS can be obtained from existing biodiversity databases which are robust enough to explain occurrences at different scales held in the database and, if so, whether a general methodology can be devised. We use different bias and autocorrelation treatments to deal with problems inherent with such data.

3.3 Methods

Area of study

Catalonia is a region of around 32000 km^2 located in the northeastern part of the Iberian Peninsula (Figure 3.1). It ranges in elevation from 0 to over 3000 m.a.s.l, from the Mediterranean coast up to the Pyrenees. Its environmental conditions are highly variable due to its complex location and topography. Although dominated by the mediterranean climate it also has continental and atlantic influences. Mediterranean and Eurosiberian biogeographic regions dominate while Subalpine and Alpine types appear in the upper zones of the Pyrenees. There is a trend of decreasing precipitation and increasing temperature towards the south (Ninyerola *et al.*, 2000). It is a highly humanized territory, particularly around the Barcelona metropolitan area. The rest of the region is dominated by forests and agroforestry mosaics with relatively large human influence although with lower intensity.

Figure 3.1: Study area

Database. As a case study we use the Biodiversity Databank of Catalonia (BDBC, http://biodiver.bio.ub.es/biocat/) (Font *et al.*, 2009). Catalonia is a region with a rich history in Botany which is reflected in the holdings of the database. For an area of around 32000 km^2, the BDBC contains above 1.5 million of plant species citations from sources such as scientific articles, PhD theses and local floras. Due to historical recording tradition among botanists and to the cost of obtaining finer georeferences, most of its data is at a coarse resolution of 10 km. Catalonia is a well-surveyed region for vascular plants at 10 km resolution. BDBC contains also more than 180000 plant occurrence records at 1 km resolution. The geographical distribution of IAS as reflected by 10 km-resolution occurrence records in the BDBC can be considered to approximate its true distribution for our study area (Pino *et al.*, 2005). Therefore, when developing models at finer resolutions their geographic distribution should be coherent with the distribution obtained from mapping the coarser data.

Species data

IAS may violate the assumption made in species distribution modelling (Peterson, 2005) that species are at equilibrium with their environment (Austin, 2002; Araújo and Pearson, 2005; De Marco Jr *et al.*, 2008); *i.e.* they may not realize their full range (Zimmermann *et al.*, 2010; Václavík and Meentemeyer, 2012). According to some studies (Williamson *et al.*, 2009; Gassó *et al.*, 2010), neophytes reach their maximum range around 150 years since their introduction in the Iberian peninsula. We used this criterion (more than 150 years since introduction) for the selection of IAS species, in addition to availability of data at 1 km resolution. The selection resulted in the 10 species shown in Table 3.1 (see also Appendix D). Of these, four of them are included in the list of DAISIE s one-hundred worst invaders in Europe (DAISIE, 2011): *Ailanthus altissima*, *Opuntia ficus-indica*, *Oxalis pes-caprae* and *Robinia pseudoacacia*.

Data independence across scales. Occurrence data at different resolutions in biodiversity atlases may not be independent; *i.e.* occurrence records at coarser resolutions may have their origin in records at finer resolutions. In order to overcome this problem we

Table 3.1: List of selected IAS for modelling

Species	**Abrv.**	**1km**[a]	**10km**[b]	**Intr**[c]	**Yrs**[d]
Agave americana L.	aga	20	124	XVIth	411
Ailanthus altissima (P. Mill.) Swingle	aia	43	213	1818	192
Amaranthus albus L.	ama	29	194	1861	149
Conyza canadiensis (L.) Cronquist	coc	73	307	1784	226
Datura stramonium L.	das	31	230	XVIth	411
Oenothera biennis L.	oeb	55	80	1848	162
Opuntia ficus-indica (L.) P. Mill.	opf	13	102	XVIth	411
Oxalis pes-caprae L.	oxp	12	41	1850	160
Robinia pseudoacacia L.	rop	66	257	XVIIIth	211
Xanthium spinosum L.	xas	56	252	XVIIIth	211

[a]Number of 1 km occurrences
[b]Number of 10 km occurrences
[c]Introduction date
[d]Number of years since introduction (conservative estimate)

only accepted 10 km squares which had at least one citation more per species than the number of 1 km citations contained therein; *i.e.* there is at least one 10 km occurrence record which is independent from 1 km data. This procedure also allowed us to use all occurrences records at 1 km resolution.

Environmental data.

We used 19 bioclimatic variables (Nix, 1986) (Table 3.2) which represent a combination of annual trends, seasonality and extreme conditions relevant to species physiological tolerances. We added two more variables regarding radiation (mean radiation of the least radiated quarter and mean radiation of the most radiated quarter) and three more variables that may partially explain distribution of IAS (distance to main harbours, distance to the coast and degree of anthropization) (Brooks, 2007; Vicente *et al.*, 2010) (See Table 3.2). We calculated the bioclimatic variables using the Digital Climatic Atlas of Catalonia (DCAC) (Ninyerola *et al.*, 2000) which holds monthly data on temperature, precipitation and radiation for the whole of Catalonia. We calculated the degree of anthropization using the Land Cover Map of Catalonia (CREAF - Centre for Ecological Research and Forestry

Applications, 2009; Ibánez and Burriel, 2010). Each land cover category was assigned a value between one (least anthropization) and five (most anthropization) (Table 3.2). Then, to represent the degree of anthropization we calculated a weighted average scaled between 0 and 100 for each 1 km square grid.

Since our goal is to predict species distributions rather than discerning which factors affect their distribution, all predictors were used for modelling each species. Extracting collinearity from the model was not necessary. Though it can hinder model interpretation, it does not affect Maxent predictive performance (Kuemmerle *et al.*, 2010).

Species distribution modelling

Modelling involved a five-step process as shown in Figure 3.2. In the first step, we modelled the species distribution at the finer resolution of 1 km following the methodology described in Case 1 (Elith *et al.*, 2011). These authors use different alternative background scenarios to account for bias, and cross-validation techniques to validate models developed with presence-only data of *Banksia prionotes* from an atlas database. Accounting for bias and autocorrelation is an important issue in species distribution modelling, specially in presence-only models (Legendre, 1993; Legendre *et al.*, 2002; Segurado *et al.*, 2006; Phillips *et al.*, 2009; Newbold, 2010; Merckx *et al.*, 2011). Since we expect fine-grained casually-collected data to show a number of biases, we included three bias correction treatments and five spatial autocorrelation correction treatments (see below) to evaluate the potential of these data to derive ecologically sound species distribution models.

This resulted in a total of 15 models per species. In a second step, only those models with an AUC (area under the curve) ≥ 0.7 not showing residual spatial autocorrelation were selected. In a third step, these selected models were upscaled to a coarser resolution of 10 km using a probabilistic model (see Equation 3.1). In step four, upscaled models were validated against the independent 10 km dataset and only those with an AUC ≥ 0.7 at 10 km resolution (AUC_{10k}) were selected. Therefore, their originating fine-scale models were, among the previously selected ones, the ones which showed acceptable predictions at both scales. Finally, in step five, if more than one fine-scale model per species had

Table 3.2: Set of environmental predictors used in modelling

Bioclimatic variables
Annual mean temperature
Minimum temperature of the coldest month
Mean temperature of the coldest year quarter
Mean temperature of the warmest year quarter
Mean temperature of the wettest year quarter
Mean temperature of the driest year quarter
Maximum temperature of the warmest month
Annual mean precipitation
Precipitation of the coldest year quarter
Precipitation of the driest month
Precipitation of the driest year quarter
Precipitation of the warmest year quarter
Precipitation of the wettest month
Precipitation of the wettest year quarter
Annual temperature range
Mean temperature diurnal range
Isothermality
Temperature seasonality
Precipitation seasonality
Mean solar radiation of the least radiated quarter
Mean solar radiation of the most radiated quarter
Landscape and physical variables
Anthropization degree
1 - Natural forests, shrublands, wetlands, grasslands, rock outcrops and screes, bare soil, beaches, glaciers and snow cover and continental waters, 2 - Recently burnt areas and reforestations, 3 - Crops and tree plantations, 4 - Agricultural water bodies and quarrying areas, 5 - Dense and sparse urban areas and roads
Coast distance
Harbour distance

been selected, we determined the best one by selecting that with the highest AUC at 1 km resolution (AUC_{1k}). Despite concerns on the use of AUC for comparing species distribution models, this metric can safely be applied when evaluating model performance within species (Lobo *et al.*, 2008; Blach-Overgaard *et al.*, 2010).

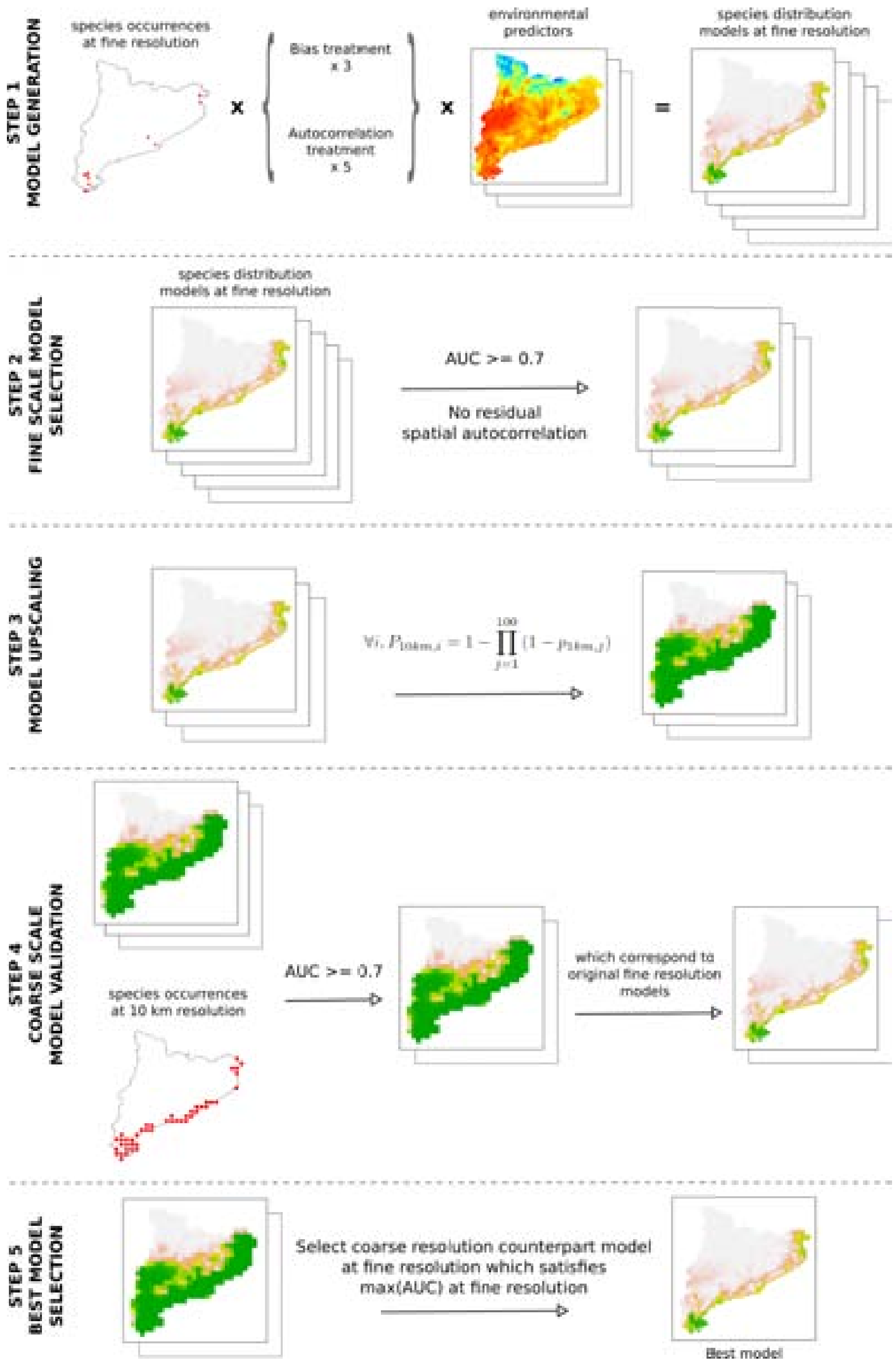


Figure 3.2: Outline for the proposed modelling workflow. Step one corresponds to the modelling of each species at 1 km resolution with three different bias treatments and five different autocorrelation treatments, which gives a total of 15 models per species. In Step two, we check for residual autocorrelation, calculate the AUC and select only those models with no residual spatial autocorrelation and with an AUC ≥ 0.7. In Step three, previously selected models are upscaled to 10 km resolution by probabilistic calculations. In Step four, a ROC analysis is performed using independent data at 10 km resolution. Models with an AUC ≥ 0.7 tell us which models at 1 km resolution are accepted. Finally, in Step five, if more than one model per species at 1 km resolution has been accepted, we define the best model as the one which has the maximum AUC_{1k}.

Bias correction treatments Background samples should be chosen to reflect the spatial bias and thus, to minimize the effects of bias in the data (Phillips *et al.*, 2009; Veloz, 2009; Elith *et al.*, 2011). We prepared three different background scenarios: a) the entire study area (coded as whole_area), b) 1 km-squares with presence of vascular plants citations (coded as vasculars1k) and c) 1-km squares with presence of IAS citations (coded as invasive1k). See Table 3.3.

Autocorrelation correction treatments Spatial autocorrelation may falsely inflate AUC measures for species distribution models with presence-only data (Segurado *et al.*, 2006; Veloz, 2009) and environmental autocorrelation may have the same effects. There is no established methodology for accounting for spatial autocorrelation when dealing with presence-only data (Dormann *et al.*, 2007). Autoregressive models are not applicable since both presence and absence data would be needed (Allouche *et al.*, 2008). We used an approach *a priori* similar to (Segurado *et al.*, 2006; Pearson *et al.*, 2007) which consisted in filtering occurrences by setting a minimum spatial and environmental distance between them and then checking for residual autocorrelation. We prepared five treatments for modelling each species. The first implied including all available presences without filtering them. The second and third involved randomly filtering and selecting occurrences so that any occurrence were at least at a spatial distance of 2830 m (two 1 km squares) and 4250 m (three 1 km squares) from each other, respectively. For the fourth and fifth treatment we used a minimum multivariate environmental distance based on the Gower s distance index with values 0.05 and 0.1, respectively (higher values resulted in an excessive reduction in occurrences). Models were then checked for significant residual autocorrelation (observed occurrence minus probability of occurrence as in (De Marco Jr *et al.*, 2008; Nunez and Medley, 2011; Václavík *et al.*, 2012)) by using Monte-Carlo simulation of Moran s I autocorrelation coefficient using package *spdep* in R (Bivand *et al.*, 2011). Only those models with a $p$value ≥ 0.05 were accepted (as shown in Table 3.3).

Table 3.3: Models with $AUC_{1K} \geq 0.7$ and no residual spatial autocorrelation at 1 km. Finally accepted models (AUC_{10K} at 10 km with ≥ 0.7) at 10 km resolution are indicated with a Y in column Accepted . In column Best , those with the highest AUC_{1K} at 1 km from the accepted models are marked with an asterisk. Columns: Sp-Species abreviation, Bias tr.-Bias treatment (*whole_area*-whole study area as background, *vasculars1k*-UTM squares with citations of vascular plants as background, *invasive1k*-UTM squares with citations of invasive plants as background), Aut. type-Autocorrelation treatment type (*spatial*-based on spatial distance, *environmental*-based on environmental distance), Min. dist.-Autocorrelation minimum distance value, AUC_{1k}-AUC value for 1 km models, AUC_{10k}-AUC value for 10 km models, M *p*value-Moran s I *p*value from Monte-Carlo simulation, Accepted-Models accepted, Best-Overall best models

Sp	**Bias tr.**	**Aut. type**	**Min. dist.**	**AUC$_{1k}$**	**M *p*value**	**AUC$_{10k}$**	**Accepted**	**Best**
aga	whole_area	spatial	4250m	0.79	0.064	0.86	Y	*
aga	vasculars1k	spatial	4250m	0.75	0.066	0.78	Y	
aia	invasive1k	spatial	2830m	0.82	0.052	0.50	N	
aia	vasculars1k	spatial	2830m	0.78	0.076	0.65	N	
aia	invasive1k	spatial	4250m	0.72	0.164	0.45	N	
aia	vasculars1k	spatial	4250m	0.72	0.124	0.67	N	
oeb	invasive1k	environmental	0.10	0.75	0.086	0.57	N	
opf	whole_area	environmental	0.10	0.87	0.074	0.85	Y	
opf	whole_area	spatial	2830m	0.87	0.072	0.85	Y	*
opf	vasculars1k	spatial	2830m	0.80	0.054	0.82	Y	
opf	whole_area	spatial	4250m	0.86	0.076	0.86	Y	
oxp	whole_area	environmental	0.10	0.92	0.172	0.92	Y	
oxp	invasive1k	environmental	0.10	0.70	0.078	0.78	Y	
oxp	vasculars1k	environmental	0.10	0.87	0.136	0.89	Y	
oxp	whole_area	spatial	0.00	0.94	0.054	0.93	Y	*
oxp	vasculars1k	spatial	2830m	0.86	0.056	0.90	Y	
rop	invasive1k	environmental	0.05	0.83	0.252	0.52	N	
rop	invasive1k	environmental	0.10	0.81	0.405	0.53	N	
xas	vasculars1k	environmental	0.05	0.75	0.150	0.69	N	
xas	vasculars1k	environmental	0.10	0.76	0.577	0.70	Y	*

Modelling and validation at 1 km resolution. We used MaxEnt software, version 3.3.3e, (Phillips *et al.*, 2006; Phillips and Dudík, 2008). MaxEnt is a presence-background modelling tool based on the maximum entropy principle. There is a wide agreement among the species distribution modelling community in considering it the best available tool for presence-only data, even when only a limited number of occurrence records is available (Elith *et al.*, 2006; Hernandez *et al.*, 2006; Phillips and Dudík, 2008; Wisz *et al.*, 2008; Elith and Graham, 2009; Thorn *et al.*, 2009; Costa *et al.*, 2010) and with bias present (Rebelo and Jones, 2010). MaxEnt estimates the distribution of maximum entropy constrained in a way that expected values for predictor variables match their empirical average (Phillips *et al.*, 2006). We used the logistic output of the model which indicates the relative environmental suitability of each pixel in relation to background for the study area (Phillips and Dudík, 2008).

We ran the model for each species with default options using the whole set of environmental predictors (Table 3.2) and following the methodology explained in Case 1 of (Elith *et al.*, 2011). A total of 150 models were generated, which correspond to ten species times three bias scenarios times five autocorrelation correction treatments. When dealing with data from atlas databases, randomly partitioning occurrence data into training and test sets and using cross-validation techniques is often the only solution available to calibrate and test a model. We used ten-fold cross-validation and then used the average of all models as the final one. As a goodness-of-fit measure we used the test AUC. As it is usually the norm in species distribution modelling we accepted only models with an AUC ≥ 0.7. Models with an AUC ≥ 0.9 are considered as excellent (Swets, 1988). As mentioned above, we only accepted models with no residual autocorrelation as tested by Moran s I autocorrelation coefficient.

Upscaling and cross-scale validation We assumed that habitat quality is related to probability of presence and upscaled each accepted model at 1 km resolution ($\text{AUC}_{1k} \geq 0.7$ and no residual spatial autocorrelation) to 10 km resolution by a basic calculation of probabilities (Equation 3.1). We computed the probability of presence for each i_{th} 10 km square of the study area ($P_{10km,i}$), given the predicted probability of presence for each 1 km square contained within it ($p_{1km,j}$). If we subtract 1 from this probability we obtain the probability of absence for this j_{th} 1 km square. For a given i_{th} 10 km square to have an absence, all of its 100 1 km squares need also to be absences. Therefore, by multiplying the probabilities of absence for each j_{th} 1 km square we get the probability of absence for the i_{th} 10 km square. Finally, by subtracting the probability of absence for a i_{th} 10 km square from 1 we get its probability of presence ($P_{10km,i}$).

$$i, P_{10km,i} = 1 - \prod_{j=1}^{100} (1 - p_{1km,j}) \tag{3.1}$$

We then performed a Receiver Operating Characteristic (ROC) analysis (ROCR package in R (Sing *et al.*, 2009)) and computed the AUC_{10k} value for each upscaled 10 km model using the independent data set at 10 km resolution. To ensure accurate prediction assessment, independent test sets should be available (Loiselle *et al.*, 2008; Veloz, 2009). Again, those models with an AUC_{10k} value ≥ 0.7 were accepted. Finally, of all models accepted for each species we selected the one with the highest AUC_{1k} value at 1 km resolution as the best one. In sum, we obtained a set of distribution maps which perform well at the finer resolution and which also predict independent records at the coarser resolution acceptably. We think these models can be considered robust and reliable given the data available.

3.4 Results

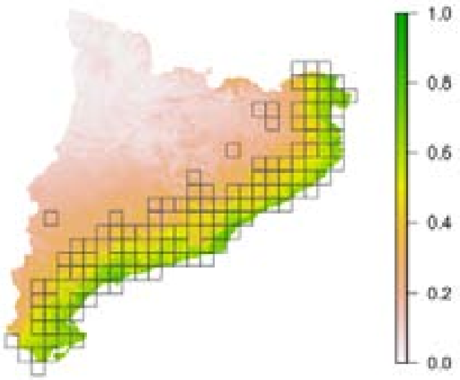
Overall, AUC test values at 1 km resolution (AUC_{1K}) ranged from as low as 0.37 to as high as 0.96 (including models with residual autocorrelation) while their corresponding upscaled models at 10 km resolution ranged from 0.45 to 0.93 (Table 3.3). Out of 150 models, 101 had an $\text{AUC}_{1K} \geq 0.7$. Of these, only 20 showed no significant residual spatial autocorrelation (Moran s p-value from Monte-Carlo simulation ≥ 0.05) . The 20 that performed well at 1 km resolution are shown in Table 3.3. AUC_{1K} test values for the accepted 20 models ranged from 0.7 to 0.94 and correspond to seven of the ten modelled species. The other three, *Amaranthus albus*, *Conyza canadensis* and *Datura stramonium*, did not perform well when modelling at 1 km resolution. *Oxalis pes-caprae* had the highest number of acceptable models at 1 km resolution but, still, the unacceptable models were the majority, ten out of 15. The rest had between 11 and 14 unacceptable models. The worst models, those with an $AUC_{1k} \leq 0.5$, were four models of *Amaranthus albus* and one of *Datura stramonium*. All of these models used the *invasive1k* bias treatment.

When evaluating performance at 10 km resolution 12 of these final 20 models had an $AUC_{10K} \geq 0.7$ and were considered as acceptable distribution models given the data available. These are: *Agave americana* (two models), *Opuntia ficus-indica* (four models), *Oxalis pes-caprae* (five models) and *Xanthium spinosum* (one model). Models marked with an asterisk correspond to our best models (see Table 3.3 and Figure 3.3); *i.e.* those with the maximum AUC_{1K} value when more than one model per species was accepted.

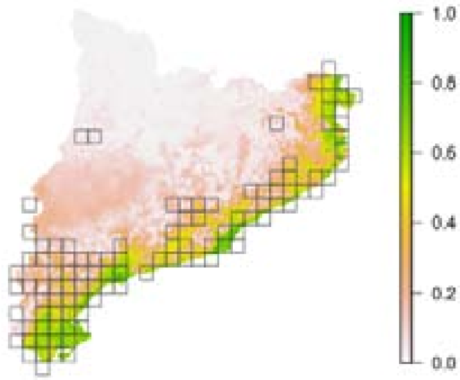
Half of the 12 finally accepted models required no bias treatment while the other half performed better when a bias treatment was applied, although only one of them showed preference for the background offered by IAS citation areas. With respect to autocorrelation treatment, six performed better with some sort of spatial autocorrelation correction, while five did so with environmental autocorrelation correction. One model needed no autocorrelation correction while none seemed to prefer the environmental correction with the shortest distance and, finally, only one model did not need either bias or autocorrelation treatment, which corresponded to *Oxalis pes-caprae*. This model also coincides with the best one of all of them, although care should be taken when comparing AUC values between species (Lobo *et al.*, 2008; Blach-Overgaard *et al.*, 2010). See Table 3.4 for a summary.

Three species, *Ailanthus altissima*, *Oenothera biennis* and *Robinia pseudoacacia*, did not pass the cross-scale validation cut (see Table 3.3). They had models which were acceptable at 1 km resolution but, once scaled, did not offer acceptable predictive power at 10 km. Thus, their finer resolution models were discarded as not being robust enough: *i.e.* they could not explain the independent data set at 10 km resolution. As an example, Figure 3.4 shows two models that, while having passed the cut at 1 km resolution modelling, show an AUC_{10k} around 0.5 which is not better than random.

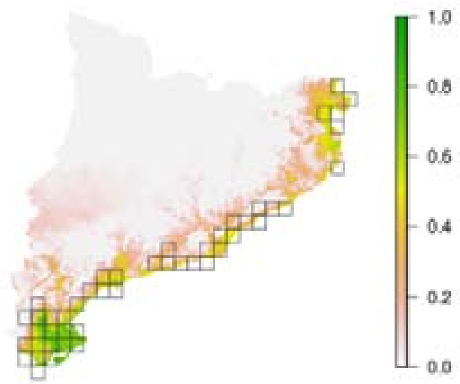
On a per species basis, *Agave americana* performed well under the *whole_area* and



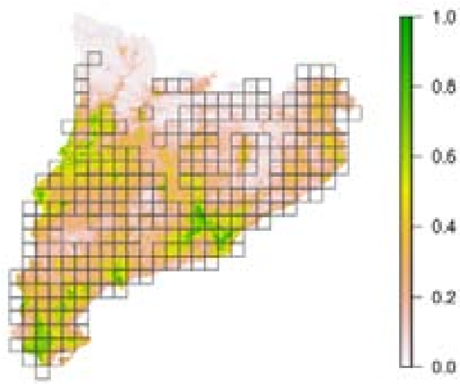
(a) *Agave americana*, AUC_{1K}=0.79, AUC_{10K}=0.86



(b) *Opuntia ficus-indica*, AUC_{10K}=0.87, AUC_{1K}=0.85



(c) *Oxalis pes-caprae*, AUC_{1K}=0.94, AUC_{10K}=0.93



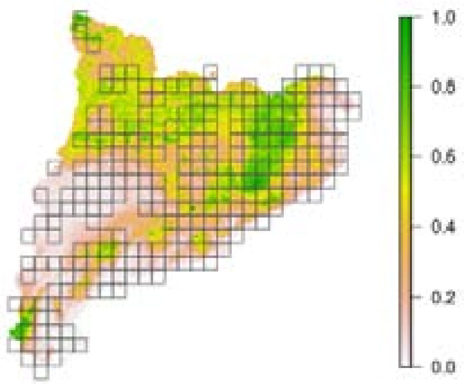
(d) *Xanthium spinosum*, AUC_{1K}=0.76, AUC_{10K}=0.7

Figure 3.3: Best models per species among all the accepted models. Only four species resulted in finally valid models at 1 km resolution. For these species, those shown in the figure are the ones with max(AUC_{1k}). Legend scale ranges from 1.0 (maximum suitability) to 0.0 (no suitability). Black empty squares represent records of presence at 10 km resolution.

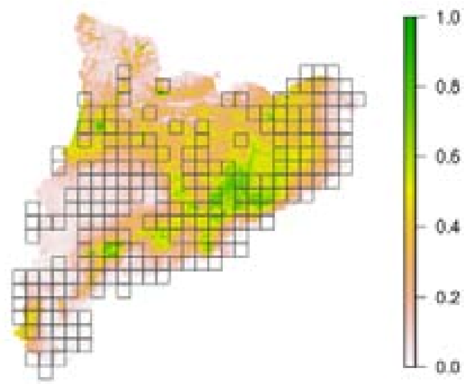
vasculars1k bias treatments and for spatial autocorrelation correction with a minimum distance of 4250 m. Its best model was the one with the bias treatment *whole_area*. *Opuntia ficus-indica* performed well under *whole_area* and *vasculars1k* bias treatments and under both environmental and spatial occurrence filtering, its best model being the one with the *whole_area* bias treatment and a spatial autocorrelation correction with a minimum distance of 2830 m. *Oxalis pes-caprae* performed well under all three bias treatments and under both spatial and environmental autocorrelation correction. Its best model required no bias or autocorrelation treatment at all. Finally, for *Xanthium spinosum* the only successful treatment was the *vasculars1k* bias treatment and the environmental autocorrelation correction with a minimum distance of 0.1. Reduction in the number of available occurrences after autocorrelation correction for the final four best models were: *Agave americana* from 20 to 12, *Opuntia ficus-indica* from 13 to ten, *Xanthium spinosum* from 56 to 22 and no reduction for *Oxalis pes-caprae* since its best model resulted in the one without autocorrelation correction.

Table 3.4: Number of finally accepted models per bias and autocorrelation treatment. Columns *whole_area*, *vasc1k* and *inv1k* indicate the bias treatment scenarios for the whole study area, vascular plants at 1 km and IAS at 1 km, respectively. Rows correspond to autocorrelation treatments: *sp_0*, *sp_2830* and *sp_4250* correspond to minimum spatial distances of 0 m (*i.e.* no treatment), 2830 m and 4250 m respectively, while *env_005* and *env_01* correspond to minimum environmental distances of 0.05 and 0.1 using the Gower dissimilarity index, respectively.

	whole_area	**vasc1k**	**inv1k**	**Total**
sp_0	1	0	0	1
sp_2830	1	2	0	3
sp_4250	2	1	0	3
env_005	0	0	0	0
env_01	2	2	1	5
Total	6	5	1	12



(a) *Robinia pseudoacacia*, AUC_{1K}=0.83, AUC_{10K}=0.52



(b) *Ailanthus altissima*, AUC_{1K}=0.82, AUC_{10K}=0.50

Figure 3.4: Examples of models that did not work. Even though these two models had a high AUC_{1K} value and showed no residual autocorrelation, they had an AUC_{10K} close to 0.5 and are thus, not better than random. Legend scale ranges from 1.0 (maximum suitability) to 0.0 (no suitability). Black empty squares represent records of presence at 10 km resolution.

3.5 Discussion

Our results show that species distribution maps derived from presence-only records held in biodiversity databases or atlases should be used with caution. Apparently, high scores in predictive power from species distributions can be obtained from scarce, biased and autocorrelated presence records using modern tools such as MaxEnt. However, our work shows that these results can be misleading when confronted with independent data at different scales. Other authors have reached similar conclusions (Wisz *et al.*, 2008). If the distribution of a species was well-known at two different scales, these should necessarily be coherent with one another. In order to generate reliable fine-resolution distribution maps, these need to be in accordance across scales (Niamir *et al.*, 2011). For a given species, its real distribution map at a fine scale should match its real distribution map at a coarser scale once upscaled. This seems not to be the case for some species, indicating that either the modelled distributions at fine resolution are wrong or that the *known* distributions at the coarser scale are, in fact, incomplete. For a well-surveyed region for vascular plants such as our study area the latter case seems unlikely. Therefore, if one accepts this assumption, our results suggest that distribution maps at the finer scales are not as good as they appear to be. If used for decision-making in conservation, they may not accomplish the objectives for which they are meant.

Of the 20 models that performed well at 1 km resolution, only 12 were coherent with data at 10 km resolution. Species-wise, it might seem that good fine-scale predictive maps could be derived from the biodiversity database for seven species. However, fine-scale distribution maps were in accordance with their coarser scale data for only four of them (Table 3.3). We can thus consider the fine-resolution maps for these four species to be sufficiently reliable for biodiversity conservation. Coarse resolution data do not often match the requirements of conservation planning (Araújo *et al.*, 2005) but, when this data are assumed to reflect the distribution of the species at the coarse scale, they can be used to make a cross-scale validation of modelled fine-scaled distribution maps, even if high predictive scores had been obtained. The resulting maps will be much more reliable and robust and will help decision-makers better meet their conservation goals.

Atlas data commonly suffer from bias and autocorrelation problems (Robertson *et al.*, 2010). Treating both hindrances is paramount to developing robust and reliable species distribution models (Segurado *et al.*, 2006; Merckx *et al.*, 2011). We tried several bias and autocorrelation correction scenarios but did not find any particular pattern in our results that can help in establishing protocols for distribution modelling. The final outcome of the modelling process can only be known on a case-by-case basis. In some instances, applying minimum spatial distances between occurrence records resulted in models without residual spatial autocorrelation while in some other cases it was the application of a minimum environmental distance which solved the problem. Except for a single case, *Oxalis-pes caprae*, we always needed to apply some sort of occurrence filtering in order to get rid of residual spatial autocorrelation.

The final message that can be taken from this study is to be always skeptical of fine-resolution maps obtained when modelling species distributions from scarce and biased data, even though they score high when measuring their predictive power. Given that current modelling techniques and computer power allow us to run many models per species taking into account different scenarios of bias and autocorrelation correction treatments, it is always sensible to do so and check, on a case-by-case basis, which one works best. Having a set of independent data to validate the model seems indispensable. Cross-scale validation, when possible, is a good solution to produce reliable and robust maps which can then be used to make better conservation decisions.

3.6 Conclusions

Casual observations at fine resolution in biodiversity atlases or databases have the potential to generate continuous species distribution maps through species distribution modelling, providing powerful tools for conservation management and planning. However, scarcity and strong biases in the data may prevent these from being possible for many species. Although high validation scores can be obtained when modelling this kind of data, there is the risk that the distribution maps reflect the data distribution rather than the true species distribution. Cross-scale validation of the data with species distribution information at a coarser scale appears as a consistent protocol to check the validity and robustness of fine resolution models and thus, make them much more reliable for decision-makers in conservation.

Fine-scale resolution maps can be derived from biodiversity atlases with problems of data scarcity, bias and autocorrelation. However, if no independent set of data is available to further validate them, results should be taken with precaution. When good coarser scale data is available, cross-scale validation appears as a good choice for checking the robustness of the data. When these options are not available, new field surveys may be the only option if reliable fine-scale maps are needed.

3.7 Acknowledgements

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Chapter 4

Handling historical information on protected-area systems and coverage. An information system for the Natura 2000 European context

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4.1 Abstract

Protected-area coverage is an internationally-recognized surrogate indicator for measuring biodiversity conservation. To measure trends in biodiversity conservation over time, historical records on protectedarea boundaries are needed. Protected-area systems represent a challenge in information management for public environmental organizations. Protected areas may be subjected to changes which must follow a mandatory multiple-step administrative process. A wealth of information is generated which needs to be stored in a way that eases the handling process and for future reference. We present an information system which handles both change on protected-area boundaries over time and their related administrative processes. It also provides distributed data maintenance functionality as well as integrated alphanumeric, file and cartographic information handling. We discuss the actual implementation of the system for handling Natura 2000 sites in the Catalan and Spanish contexts. The designed system is applicable to other European Union member states.

Keywords protected areas, protected areas coverage, Natura 2000, historical trends, biodiversity indicators, information systems (IS), conservation databases, protected area boundaries

4.2 Introduction

Protected areas are legal instruments specially dedicated to the protection and maintenance of biological diversity (IUCN, 2010). Protected-area coverage is widely used as a surrogate indicator, *proxy*, for estimating trends in the protection of biodiversity (United Nations Environment Programme, 2009; United Nations Development Programme, 2009; United Nations Environment Programme, 2006; European Environment Agency, 2005; Millenium Ecosystem Assessment, 2005; Chape *et al.*, 2005). Protected area coverage is calculated by adding the area of each protected area in a given region as defined by their boundaries.

The Convention on Biological Diversity (United Nations Environmental Programmme (UNEP), 1992) strongly recommends that signing parties establish a system of protected areas in order to conserve biological diversity. Spatially-enabled databases are needed to perform gap analysis and evaluate nature protection (UNEP - WCMC, 2008; Scott *et al.*, 1993). Such evaluations provide important insight on where new resources should be placed (Brooks *et al.*, 2004; Scott *et al.*, 1993). To analyze trends in nature protection over time historical boundary records are needed.

Nature protection frameworks at the regional, national and international levels conform a series of overlapping cartographic boundaries and regulations which represent not only a major challenge for decision-making but also for information management in public environmental organizations. These organizations need tools for querying and analyzing this intricate and geographically-tied web of legal texts. These tools not only serve the purpose of well-organized, accessible, comprehensive, quality and up-to-date historical repositories of information but can also assist them in dealing with long legal processes with conflicting parties.

Current technological development in information and communication technologies (ICT) offers an unprecedented opportunity to greatly enhance the handling, analysis and public dissemination of environmental information. Governmental organizations are required and recommended by competent bodies to make public such information (The

Council of the European Communities, 2003; World Commission on Protected Areas (IUCN), 2005). They are responsible for providing reports and accounts of statistics on protected areas including historical information (European Environment Agency, 2007).

The European Union nature protection policy is based upon Natura 2000, a coherent ecological network of protected areas comprising *Special Areas of Conservation*(SAC) (The Council of the European Communities, 1992) and *Special Protection Areas*(SPA) (The Council of the European Communities, 1979). European Union member states are responsible for submitting to the European Union a list of *Sites of Community Importance* (SCI) for approval and declaration as SAC. After this process, protected areas may also still preserve their former protection category. Thus, Natura 2000 represents a further level of legal complexity. In the case of Catalonia, in a single administrative process, 73 new protected areas have been added to the already existing list of other types of protected areas managed by the Catalan government (Generalitat de Catalunya, 2006, 2007).

Protected areas are not static legal entities over time but undergo changes in their regulations which follow the legal and socioeconomic contexts at any given moment. These changes may not only affect the existing set of regulations but also their boundaries; *i.e.*, they get extended, reduced, reclassified, amalgamated with neighbouring sites, renamed, etc. (Fish *et al.*, 2005). To be legally valid, each of these changes must undergo a mandatory, strict and predefined administrative process that involves a series of steps starting at the initial proposal by the promoting party, *e.g.*, the public administration, and ending with the publication of the approved legal text in the official governmental bulletin. Each of these steps may introduce interim changes in the working set of boundaries; some of them due to claims placed by affected parties, *i.e.*, local administrations and the public in general. An accurate handling of all this information is crucial for an effective guidance of the process and for ensuring adequate treatment of this external participation. Historical digital archives, *i.e.*, databases, represent a fundamental tool for handling all this information. They also provide the base from which it is possible to understand the historical context of protected area establishment (UNEP - WCMC, 2008; United Nations Economic Commission for Europe (UNECE), 1998) and evaluating protected area coverage over time is possible.

Handling of historical information in reference protected area databases To our knowledge, only the World Database on Protected Areas (WDPA) holds information on historical changes in protected areas (UNEP - WCMC, 2009; Chape *et al.*, 2005; Fish *et al.*, 2005). However, the scope and aim of the WDPA is quite different from the information system we present. WDPA is a global compilation of information offered via a web site in a digested way. As of February 2010, Natura 2000 sites are still not available at the WDPA (IUCN-UNEP, 2010; UNEP - WCMC, 2009). We present an information system which handles historical versions of protected area boundaries and assists in handling the administrative work involved in protected area declaration, modification and termination.

The Protected Areas Database of the United States of America is a collaborative effort between governmental and non-profit organizations. Its latest downloadable version, released April 2009, does not contain historical information and its plans only include the date of establishment of protected areas for a later date(GreenInfo Network, 2008; Conservation Biology Institute, 2008).

In Australia, the Collaborative Australian Protected Areas Database (CAPAD) is a textual and spatial database compiled from information supplied by the Australian, State, and Territory Governments and other protected area managers (Australian Department of the Environment, Water, Heritage and the Arts, 2008). CAPAD s GIS layer contains only the latest valid boundaries with only information on the gazettal date of the original proclamation and the date of the most recent gazetted amendment but not a complete historical record of changes (Australian Department of the Environment, Water, Heritage and the Arts, 2008; Australian Department of the Environment and Heritage, 2004).

The European Common Database on Designated Areas (CDDA) offers information on the nationally designated sites for the Natura 2000 ecological network (European Environment Agency, 2009b). The CDDA database holds only information on the gazettal date of original declaration and latest amendment but not its historical track (European Environment Agency, 2009c). There is a recommendation that the structure be redesigned to accommodate historical information (European Environment Agency, 2007).

In Germany, a member state of the European Union, the map service of the Federal Agency for Nature Conservation offers only the latest available official boundaries and the year of the protected area establishment (German Federal Nature Conservation Agency (BfN), 2009).

In Spain, another member state of the European Union, the Spanish chapter of the Federation of Nature and National Parks of Europe holds the Protected Areas Observatory (Europarc Espana, 2009) and provides only the latest available boundaries, the year of the protected area declaration and the latest legal modification.

In this paper, we present an information system, a module of the *Natural Heritage Information System of Catalonia (SIPAN)* of the Catalan government, which can handle change in protected area boundaries at two nested-levels. At the first level, every single regulatory change is recorded. At the second nested level, every interim change due to the administrative process handling of the first-level regulatory change is also recorded. The first level allows for the tracking of trends in protected area coverage through time. The second level helps public environmental organizations in driving the process of protected area change. The system is comprehensive to the whole of the protected area system in Catalonia. We use Natura 2000 as an example on which to demonstrate it. Information can be fed to reference databases such as WPDA (IUCN, 2004) and CDDA (European Environment Agency, 2009a) as recommended by the Convention of Biological Diversity (United Nations Environmental Programme, 2008).

The complexity of policy frameworks in different environmental domains, in the European Union and elsewhere, makes environmental information systems a necessity for policy makers and for the public. The contribution of this paper in information management on the biodiversity protection domain is in line with other efforts in different environmental domains such as (Calder *et al.*, 2008; Tuchyna, 2006; Culshaw *et al.*, 2006; Dupmeier and Geiger, 2006; Uslander, 2005). Furthermore, such a system could feed other environmental systems which use spatio-temporal information on nature protection or land-use for a range of environmental analyses including global change (Schaldach and Alcamo, 2006).

4.3 Legal context

The Birds and Habitats directives constitute the basic European policy framework for nature conservation (The Council of the European Communities, 1992, 1979, 1997). They declare *Natura 2000* as a *coherent ecological network* composed of *Special Areas of Conservation (SAC)*. SAC represent sites in need of conservation for containing habitats of European value or parts of the distribution areas of species of European value. In the case of Spain, several legal texts transpose these directives and establish the legal framework by which regional governments, *e.g. the government of Catalonia*, are entitled to propose and declare Natura 2000 sites (Gobierno del Estado Espanol, 1998, 1995, 1989).

The government of Catalonia, coordinated with the rest of regional governments by the Spanish Government, submitted to the European Union the list of Sites of Community Importance (Generalitat de Catalunya, 2006, 2007; Parlament de Catalunya, 2006). All sites proposed as SCI are incorporated into the Catalan protected area network.

The administrative process, from proposal to official approval

The handling of an *Administrative process*, such as that of declaration of SACs, involves a set of predefined steps by which an initial government proposal ends in the final approval of some sort of action, *e.g.*, the declaration of a new protected area.

The approval of Natura 2000 *Special Areas of Conservation* is a three-step process (European Commission, 1997): first, member states make a draft proposal of a list of *Sites of Community Importance*. Second, the European Commission in agreement with the member states, establishes the list as official. Third, member states designate the sites as *Special Areas of Conservation* providing them with protected area status. Figure 4.1 illustrates this process for Catalonia.

Our system solves the challenge of handling all information involved in administrative

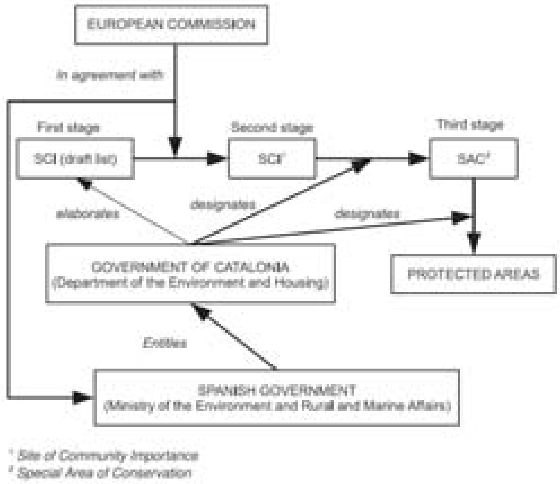

Figure 4.1: The three stages of Natura 2000 sites designation and actors involved

processes such as that depicted in Figure 4.1 and keeping historical records of it.

4.4 System design and implementation

Requirements and general architecture

Requirements The system needs to meet its intended use of managing historical and administrative handling information on regulatory and boundaries change in protected areas. As the system is aimed at public environmental organizations which normally have decentralized offices in rural settings, *e.g.* park headquarters, communications infrastructure in such organizations can be of very diverse quality, having both high-bandwidth, normally in central offices in cities, and low-bandwidth, normally in those rural sites. This establishes another important requirement, functional in nature, namely the application should perform acceptably in both low and high-bandwidth networks. It should also offer the user a rich and friendly experience in the sense of ease of use. In this respect, the system needs to handle alphanumeric information, documents, images and cartography from within a single application with no need of external tools. Another requirement is a user authentication and permission definition mechanism that enables to restrict access to editing data at different degrees. Finally, the effort put into design and development of such an application should also be of use when developing the version offered for public dissemination of information.

General architecture The system is structured in three layers as shown in Figure 4.2. The first layer is a rich-client desktop application which handles queries and results, builds the business-logic objects and interacts with the user. The second layer is a server application which translates requests sent by the client in the form of *Java* objects into SQL (*Structured Query Language*) queries understandable by the database, converts the result sets from the database to data arrays stored in a single instance of a *Java* object, compresses the object in order to speed data transfer, and sends it back to the client. The third layer is a data persistance unit consisting of a back-end relational database management system.

Caching and editing functionality Data retrieved from the database are locally stored, *cached*, in the user s directory, enabling the desktop application to work with local data instead of having to go back and forth from the database. When needed, these *cached* data are synchronized with the database back-end: at user request or when entering editing mode. The user can always request the latest available information for that particular protected area by synchronizing the local *cache* with the database. This *caching* mechanism ensures higher responsiveness of the application and a richer user experience both in high and low-bandwidth contexts.

The application is meant to share data editing tasks in a distributed way. In order to prevent collisions in data editing between different users, a record-blocking mechanism enabled at the protected area level ensures that at any given moment only one user is able to modify data on a given protected area. Once the user is done with the modifications on the protected area the block is released and the area is available again for further editing.

Document and image handling The application allows to attach as many documents, *e.g.* legal texts, and images to a protected area as needed. Specific panels allow the handling of this type of information. Documents and images are sent by the client as binary streams and stored as binary large objects in the database back-end. For size and

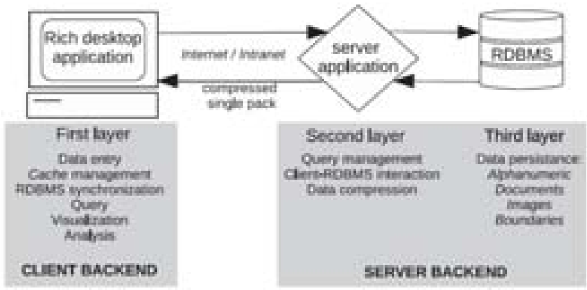

Figure 4.2: General architecture of the system. A server application mediates between the client and the database. It sends data in a compressed form to the client, which uncompresses them and keeps a local *cache* synchronized with the database. Data (alphanumeric, documents, images and cartography) are stored in a central database repository.

performance reasons, documents and images are not *cached*. They are retrieved from the database on demand and not locally stored. Documents can be attached at the level of the protected area and at the level of administrative step. This enables each administrative step to hold its resulting legal text.

Cartography We developed a cartography browser/editor tool which is embedded at different places within the application, *i.e.* at the protected area level for visualizing the latest valid boundaries and at the administrative process step. In the latter case, it stores each version corresponding to each interim change in boundaries. The version held at the last administrative step of the latest approved legal text contains the current valid boundaries for the protected area. The tool relies upon existing OGC-compliant WMS servers for offering background cartographic layers onto which boundaries can be displayed and edited. The usual visualizing (pan, zoom) and editing (points, lines, polygons) capabilities are offered. Also, boundaries can be imported from text files in MiraMon (Pons, 2004) format. In memory, boundaries are stored as objects conformant to Open Geospatial Consortium Standards (Open Geospatial Consortium Inc, 2006). In the database back-end they are persisted as relational data. For the same reason as with documents and images, boundaries are not included in the local *cached* data but are retrieved when needed. Since most times the user will only work with the latest valid boundaries of a protected area, for performance reasons a redundant copy of the last valid limits is stored in a compressed zip file in the database. However, contrary to what was done with documents and images, once at the client they are stored in the local file system temporarily. This makes the process of retrieving such cartographic information from the database much faster.

Object model

Classes and interfaces The major classes of objects in our design can be seen in Figure 4.3. The *Protected area* class is the key target of our system; it holds all information associated with protected areas in a tree-like structure. Each *protected area* object contains the *administrative process* objects that affect it and, in turn, each *administrative process* object contains the set of *administrative step* objects that conform its mandatory handling. The final *administrative step* object ends with the publication of the *Legal text* in the government s official journal which declares, modifies or terminates its parent *protected area* object. Each step may also reference a *Geometry* object which represents the boundaries set at that particular step. This results in an effective storage of all versions of the boundaries along the process. The final approved boundaries by the *Legal text* are held by the last step.

An *administrative process* is comprised of a specific set of mandatory *Handling step*s. At some point, *i.e. handling step*, public and local administrations are allowed and encouraged to participate. This participation may end in a list of *claim*s to the proposal being considered. Some of these *claim*s may be positively considered and end up in modifications of the *Legal text* and/or *Geometry*.

Since an *administrative process* may affect one or more protected areas, the list of *administrative process* objects is not directly contained within the list of *protected area* objects. Instead, each *protected area* object has a list of references that point to the *administrative process* objects that affect it. On the other hand, each *administrative step* belongs only to one *administrative process*, and thus, the object is contained within this *administrative process*. An *administrative process* may affect a given *protected area* in more than one way, *e.g.* it may rename it, redefine its boundaries, etc. The responsibility of the *Action* object is to link *Protected area*s with *administrative process*es with as many types of modifications as the *administrative process* causes on the *protected area*.

The protection category of a *Protected area*, *e.g.*, *SAC*, is defined by the related *Legal instrument* object which in turn is defined within a *Legal text*. Since a *Protected area* object has several boundaries attached to it, it needs to implement a *Visual cartography* interface that forces the implementation of the object behaviour for providing the default cartographic visualization of the protected area boundaries; *i.e.* its latest valid boundaries.

In some cases, a *Legal instrument* may be a container of other *Legal instrument*s that together form a related set of objects. The Natura 2000 network represents a *Legal instrument* defined in a given *Legal text* which gives ecological cohesion to other *Legal instrument*s: Special Areas of Conservation and Special Protection areas.

Finally, the *Legal text* class has a relation to itself in order to accommodate information on how *Legal text*s affect one another.

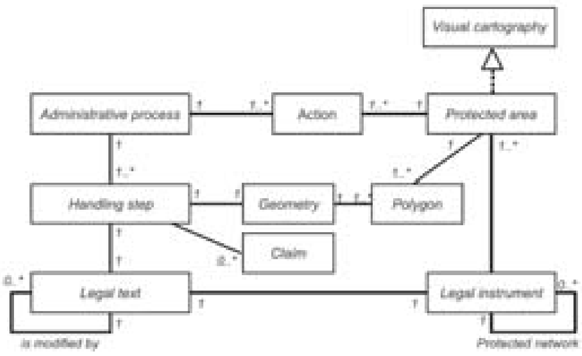

Figure 4.3: Relations among main classes. How to read the notation: 1 is `only one , 1..* is `one or more , 0..* is `zero or more . As an example, the relation between `administrative process and `action should be interpreted as `each administrative process is related to one or more actions and each action is related to only one administrative process.

Spatial databases

Boundaries are represented as *Geometry* objects which conform to OGC standards (Open Geospatial Consortium Inc, 2006). These objects are not directly linked to the *Protected area* objects but to the *Administrative step* objects of their *Administrative process*es. The final *Handling step* object will reference the final *Legal text* object and the

Geometry object corresponding to the boundaries set by it. Therefore, a given *Protected area* object has access to all *Geometry* objects, *i.e.* boundaries, that form their historical coverage evolution. Thus, *Protected area* objects can be queried for all their chronologically ordered changes that, through *Legal text*s, have led them from their declaration to the latest valid boundaries (see `F and `G in Figure 4.4). Historical changes can thus be traced and coverage change through time evaluated for the whole network.

Geometry objects can be accessed from the *Legal text* objects that define them. Since a given *Legal text* may declare, modify or terminate any number of protected areas, it is necessary to label all polygons contained in their referenced *Geometry* objects with the *Protected area* object they belong to (Figure 4.3). This can be done with a specific tool in the cartography panel of the application (see `D in Figure 4.4). With this design, boundaries can be retrieved both from the *Administrative processes* that led to them and from the protected areas they affect but only one single copy of each boundary is handled and stored by the system.

Technology used

We developed the whole system around Java technology[1], and used Oracle 9i[2] as the database back-end. The application has been targeted to the Java 1.5+ versions. Background cartography is collected from available WMS-compliant servers. We also make use of the open source libraries Java Topology Suite[3] and JasperReports[4]. The system is designed in such a way that it can also work with other databases such as MySQL[5].

Deployment

The application is deployed via *Java Web Start Technology*[6] which allows for authomatic updating of client applications. This proves a convenient way to ensure that users always have the latest available version.

[1]http://java.sun.com
[2]http://www.oracle.com/index.html
[3]http://www.vividsolutions.com/jts/jtshome.htm
[4]http://www.vividsolutions.com/jts/jtshome.htm
[5]http://www.mysql.com/
[6]http://java.sun.com/javase/technologies/desktop/javawebstart/index.jsp

User interface

The client layer is an application with querying, visualizing, editing and exporting capabilities.

User authentication and permissions To enter the system the user needs to authenticate through a login panel using a user name and a password. Once authenticated, data are loaded from the database if not already *cached*. Editing permission can be given on a per-protected-area basis. This allows for distributed curatorship of protected area information. Each protected area management team can take care of the information of their own protected area. By default, all users have read-only access to all information.

Data entry Data are entered by means of several entry forms (see `A, B, C, D in Figure 4.4): one for basic protected area information, another for administrative processes and others for thesaurus-like information, *e.g.*, legal texts. With the protected area form, the user enters basic information such as code, name, and protection category. In the administrative process form, the user enters data on all administrative processes and their handling steps. Documents and cartography can be entered within each step. Since cartography representing the boundaries of the protected areas is defined in the legal texts, both are entered at the same level in this data entry form. The last step of an administrative process contains the cartography finally approved by the process and each previous step may contain drafts of the cartography that led to this final version. Once the cartography, *i.e.*, the polygonal boundaries, has been entered, each polygon is linked to the corresponding protected area object it applies to. Thus, only a single copy of the boundaries exist and is accessible both from the protected area object and from the administrative process and legal text objects. From within the protected area form, administrative processes with their associated legal texts and cartography are visible (see `D in 4.4), but not editable.

Query and visualization The application offers multiple-criteria filtering functionality through a specific panel. Once data are filtered, all data entry, query and visualizing panels can be set to only show the filtered subset of elements. A tree-like display of protected

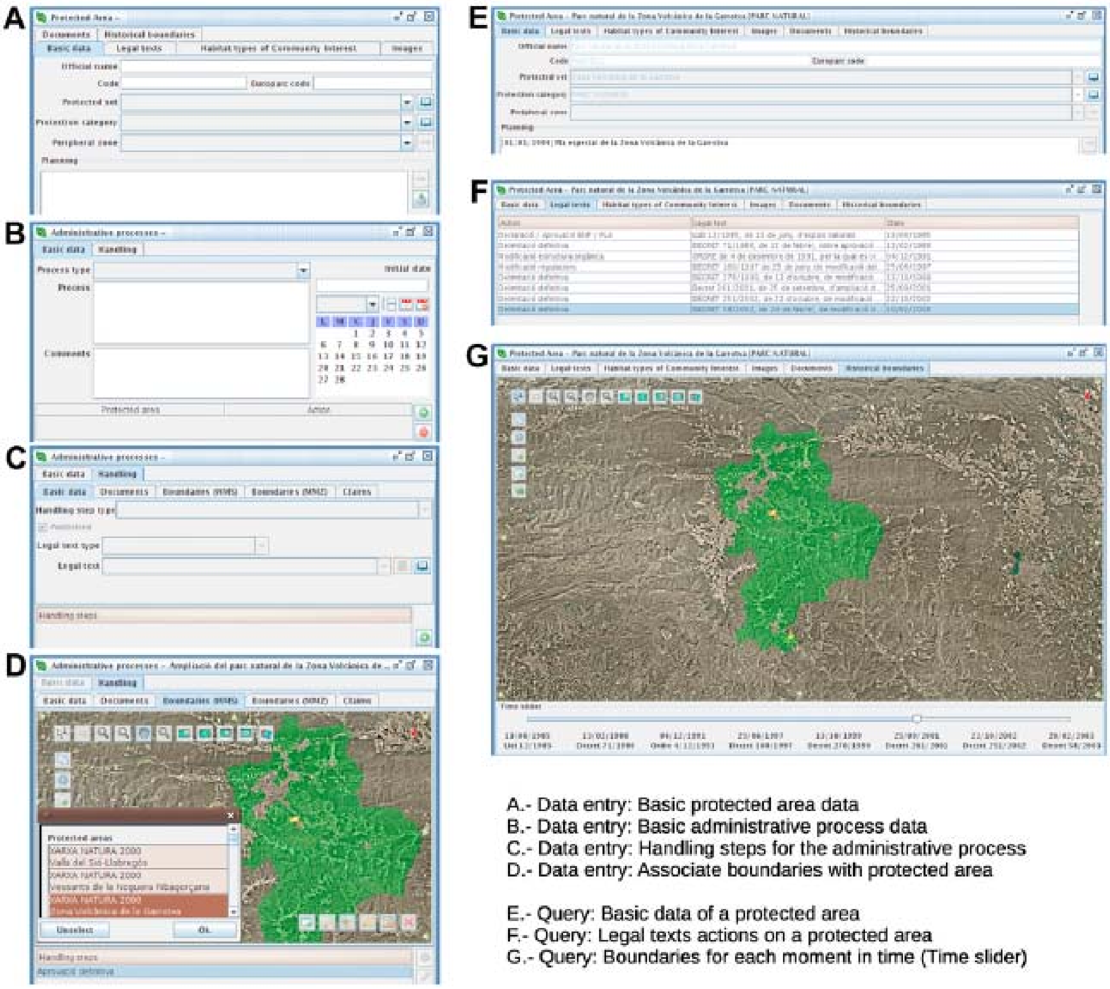

Figure 4.4: Partial screenshots of the user interface for entering (as explained in Figure 4.5) and querying protected area data. Once data are entered all legal texts affecting each protected area become visible. A time slider control (please note it in `G) in the cartography browser allows the visualization of historical cartographic boundaries

areas and administrative processes offers the user data browsing, editing and reporting capabilities from within it. A navigator panel allows the user to step through all protected areas and administrative processes and to directly go to a given one selected from a list. Sites can also be browsed through a hierarchical tree navigator. Protected area boundaries can be visualized individually in the protected area panel or together (using the filter or not) in a general cartography panel.

Reports, graphics and data export Several reporting templates are available for producing reports of single objects (protected areas or administrative processes) and multiple objects in an aggregated form; *e.g.* protected area coverage per category type and administrative unit. Several types of graphics can be dynamically obtained by choosing predefined sets of dependent and independent variables. The user can customize exports of data to *CSV* (Comma Separated Values). Cartographic data can also be exported to the MiraMon GIS format. When producing reports, graphics or exports the user may choose whether to use the full or the filtered dataset.

Functionality example

In this subsection, we give an overview on how to manage the process of declaration of a new protected area with its set of boundaries and the process of adding a new set of boundaries to an existing protected area. Figures 4.4 and 4.5 illustrate this.

Protected area declaration The necessary actions a user must take care of when addressing the process of declaration of a new protected area can be seen in Figure 4.5. In the case of Natura 2000 sites, the process starts by creating a new protected area of protection type *Natura 2000*. Once created, the application adds it to the system s *protected area list*. The second step involves adding a new *administrative process* to the *administrative process list*; that is, a container for the information regarding the handling of protected area declaration information. Then, we associate it to the protected area created before and assign a *declaration action type* to it. This is done by selecting the protected area from the corresponding dropdown lists in the *administrative process* data entry panel. Thus, we now have an open administrative process for handling the process of declaration of a new Natura 2000 site. Through the real administrative process, every single handling step taken will be added to this declaration process. In Figure 4.1, we can see the three main stages, *i.e.* handling steps, which involve the declaration of a Natura 2000 site. There may also exist other intermediate steps in between the three main stages seen in Figure 4.1. The list of predefined mandatory handling steps for each type of administrative process is entered into the system. Then, the user fills each of them with the appropiate information which in some cases will also involve cartographic boundaries. When these are set, the user interface allows to link them to the protected area they modify.

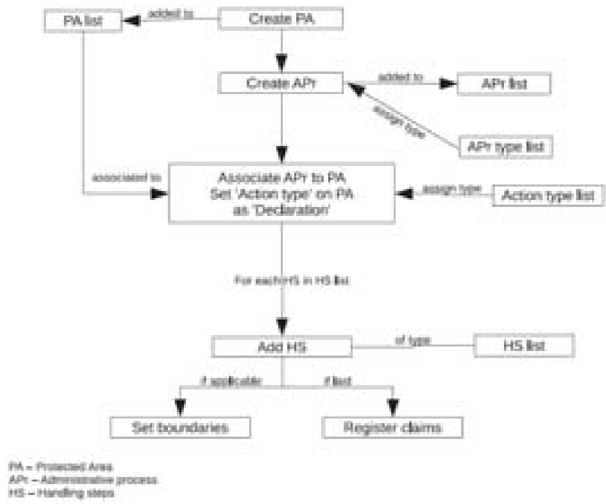

Figure 4.5: Flow diagram for declaration of protected area

Modification of boundaries The process of modification of boundaries in a given protected area is the same as in the creation of a new protected area, the only difference being that the protected area already exists and the process starts in the second step of Figure 4.5, *Create APr*. A new administrative process is created which will specify all handling steps involved until the final approval of the new boundaries as in the previous example. By repeating this, all administrative processes and their corresponding boundaries resulting from the final approval of their legal texts will be available from the information contained in the protected area. As a result, we will be able to see the historical boundary changes of each protected area (see `F  and `G in Figure 4.4).

4.5 Discussion

Applicability and usability

The application has been designed and implemented for dealing with protected area information in the legal framework of Catalonia, Spain. Although not fully investigated, the same design should apply seamlessly to the rest of regional governments in Spain since all depend on the same Spanish and European legal frameworks. For the very same reason, this design should also be applicable to other member states of the European Union with minimal tuning of the application and database. The application has been implemented with multiple-language support.

The application has been tested by entering data (alphanumeric, documents, images and boundaries) corresponding to over 450 protected areas of different protection categories and to more than 130 administrative processes which declare, modify or terminate these protected areas. The system has proved useful for handling and storing such diverse set of cases, protected areas of different category linked through different action types to different types of administrative processes and legal texts.

One of the main benefits in ease of use for the final user is the integration of tools for dealing with different kinds of information (alphanumeric, files and cartography) on a single application. The user does not need to leave the application when handling the cartographic representation of the protected areas, *e.g.* boundaries.

Performance issues

Environmental public administrations may have buildings located in areas with low-bandwidth connections. Being able to browse and edit protected area information including documents, images and cartography located in remote servers is a difficult task. Developing applications that deal with large volumes of data and that respond readily to user interaction represents sometimes an unattainable goal without improving network infrastructures. We have experienced that traditional web applications have proved unsatisfactory in performance terms in low-bandwidth contexts since many client-server interactions are needed and, as a result, application performance is severely degraded, leaving the user with frozen and unresponsive screens. AJAX[7] technologies provide performance improvements though user interfaces are not as powerful as rich-client desktop applications. Rich-client technologies also present performance issues if no *caching* mechanism is used. Resultset

[7] *Asynchronous Javascript and XML*

cursors from database queries slow down the application when accessed from remote clients. The *caching* mechanism we developed minimizes client-server interaction and improves application performance and responsiveness. Clients only have an initial delay when loading data for the first time. Then, the application works with a local *cache* of this data and synchronizes it with the database back-end when needed. Since the application has all data either in-memory or on-disk, performance and responsiveness are greatly enhanced. A disadvantage of this technique over web applications is that clients need to have a Java virtual machine pre-installed, although this is partially solved as most users normally already have it. Although web applications do not present this disadvantage, the existence of unavoidable differences in behaviour of different Internet browsers are also a factor that substantially increases the development effort when developing web applications. However, more development effort is being put into further decoupling the presentation layer and the business layer so that it becomes possible to offer both a web and desktop interface working against the same business layer. A web presentation layer could be offered for public consultation and a richer desktop application would be used for intensive work by the technical staff of the public administration.

Error control

Two types of errors can affect the system. The first type of errors originates from the process of data entry itself; i.e. errors can be committed to the database when a user enters data. To minimize such errors, data entry form controls use field validation and lookup tables. However, expert revision of data before making it public is necessary. Boundaries are first finely digitized with a GIS software package using quality reference cartography, mainly 1:5000 topographic maps, and then imported into the system. The second type of errors are those derived from using different cartographic datasets in different moments. Historical boundaries are defined using their contemporary reference cartography. Reference cartography such as topographic maps and orthophotos is in a constant process of revision and improvement. As reference cartography changes, protected area boundaries must also change in order to be perfectly fitted to current official cartography. This second type of error has a much more difficult solution. One can only try to estimate it and take it into account when comparing protected area coverage between two datasets that used different reference cartography. Although it is beyond the scope of this paper and not explored, we think this error may not represent important changes in overall protected area coverage estimation. Calculated coverages and trends should differ minimally. Another, more costly and almost impractical solution would be to always manually update protected area boundaries to the most recent reference cartography. However, a drawback would be that a protected area represented on top of the reference cartography used for digitizing it would not fit correctly and would work against other uses such as visual representation of historical cartography.

Benefits of the system

Having structured historical information on protected area boundaries for all protection categories in a given territorial extent provides several benefits. First, it allows to monitor protected area coverage over time, *i.e.* a surrogate indicator of biodiversity protection. Second, having organized and spatially-explicit historical information on protected areas raises the possibility of performing cross-analyses with many other datasets on population, agriculture, forestry, local planning, etc. Such analyses may allow to discover the social, economical and political factors driving changes in protected area coverage over time and predict future land protection scenarios. Third, such systems can become important data providers for international efforts at data gathering for analysing global trends in protected area coverage such as WDPA. In addition, they can be converted into web services, similar to other web services in different environmental domains (Goodall *et al.*, 2008; Tuchyna, 2006), which can deliver on-demand protected area boundaries for a given historical moment. Our system represents a superset of information held by WDPA for its minimum and core set of attributes (UNEP - WCMC, 2010). Feeding data into WDPA can be done by exporting information as specified in WDPA Data Standards. Work is in progress for also covering its *enhanced* set of attributes. Currently, there exist licensing and/or publishing restrictions on submitting data to WDPA on Natura 2000 sites (UNEP

- WCMC, 2009), although UNEP-WCMC is working to solve them. And finally, such type of systems become almost mandatory for public environmental organizations in order to make a proper custody of such information while providing advanced information services to individual citizens, the private and the public sector.

Further work

Further work will be aimed at enriching the database with information on habitats and species present in the protected areas and on planning and management information. With respect to the application, we will concentrate our effort on improving the user experience by further improving the application performance, *i.e.*, making the local *cache* mechanism more efficient, and expanding the application features such as adding more custom-made maps, reports and graphics. We are currently working on enabling the application to import and export cartography in the OGC-standard GML format[8].

Developments are currently under way to further separate the presentation and business layers so that the client layer can be offered both as a rich desktop client application or as a thin web application working against the same business logic layer. The former is aimed at the government s administrative and technical staff and the latter at bringing information to the general public without the need to fully develop a separate environment.

Currently, cartographic data are stored and offered to the user in the UTM-ED50 reference system. We plan to convert these data from the current ED50 datum to the new pan-European ETRS89 datum, as recommended by resolution of the European IAG Reference Frame Sub-Commission for Europe (International Association of Geodesy, 1990) and mandated by the Spanish regulation (Gobierno del Estado Espanol, 2007).

4.6 Conclusions

We have presented an information system for helping public administrations in dealing with the complex and interwoven set of information regarding protected areas, administrative processes and legal texts. For any type of legally defined protection category, it

[8]Geography Markup Language

can handle historical information, including boundaries, on the administrative processes involved in protected area declaration, modification and termination. Thus, it can monitor protected area coverage over time, a surrogate indicator of biodiversity protection.

Regional and national governments can also benefit from such a system for feeding data to reference databases such as the World Database on Protected Areas and the European Common Database on Designated Areas.

4.7 Acknowledgements

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Chapter 5

General discussion, conclusions and further research

5.1 General discussion

This dissertation has two main focus points: a) how to stretch the possibilities of scarce, problematic species occurrence data to derive information which is useful in conservation planning and management (Chapters 2 and 3) and b) how to organise information on biodiversity protection, *i.e.* protected areas boundaries, to be combined with the former in biodiversity conservation assessments (Chapter 4). It combines concepts and tools from three very broad fields: biodiversity conservation, species distribution modelling and information systems. Such interdisciplinary research is important in order to face the biodiversity conservation challenges society has (Krishtalka and Humphrey, 2000; Schnase *et al.*, 2003). We live in a rapidly changing world which threatens many of the given assets that nature provides us (Sala *et al.*, 2000). One of these assets is biodiversity, at all of its levels, from genes up to whole biomes and the Biosphere. Biodiversity is essential to our survival and well-being (Pimm *et al.*, 1995). It is thus of paramount importance to make the best use of the available tools we have: a large growing amount of data compiled in biodiversity databases and new sophisticated modelling tools which can help in dealing with several shortcomings of those data.

Biodiversity data, however problematic, is a fundamental asset at our disposal to tackle the problem of biodiversity conservation. Within the scope of this dissertation and in order to explore new avenues and ways of making the best use of available species occurrence data I have chosen two conservation challenges as examples to work with. In Chapter 2, I have examined how to use available species occurrence data to model SCI to assess their conservation and protection status. In Chapter 3 we explored the other side of the coin: to what degree can we pull occurrence data held in biodiversity databases to assess the threat posed to native biodiversity by IAS. In the first case, the knowledge gained can lead to the identification of priority areas for conservation as in Cabeza *et al.* (2004) and, in the second case, of areas with risk of invasion by alien species as in Jiménez-Valverde *et al.* (2011). If protected areas are our biodiversity crown jewels we need to assess their effectiveness in protecting native biodiversity and the extent to which they are under threat.

An important and often overlooked aspect of data is that of organisation and availability. Protected areas are a very cost-effective means (Balmford *et al.*, 2002) and a cornerstone in biodiversity protection (Margules and Pressey, 2000; Rodrigues *et al.*, 2004b). We have chosen protected areas boundaries as an example case of the issues involved in data organisation and availability. Protected areas boundaries are quite a complex problem of data organization as we have seen in Chapter 4. Tackling this kind of problem allowed us to link primary biodiversity data exploration and modelling with biodiversity conservation.

The aim of this final chapter is to discuss and highlight, from a broad perspective, the knowledge gained during the development of the work that led to this dissertation, particularly as regards to the use of these methodologies and technologies for biodiversity conservation. First, I will focus on the particularities of primary biodiversity data and environmental data, their availability and usability. Second, I present my general conclusions about species modelling tools for range map generation. Finally, I provide an overview of the issues that need to be addressed with when organising data on protected areas boundaries.

The need for data

Occurrence data

The quality of species occurrence data in all of their facets (see Figure 1.1 in Chapter 1), specially bias and autocorrelation, together with data quantity, greatly determines how to approach distribution modelling. Despite using the same algorithm, Maxent (Phillips *et al.*, 2006), different approaches were needed due to the differences of data quality between the SCI dataset used in Chapter 2 (high-quality data with relatively lower bias) and the IAS dataset used in Chapter 3 (data of unknown quality with strong bias). Maxent has been used for both SCI and IAS due to the favorable reviews of the algorithm for modelling presence-only data with a limited number of occurrences (Elith *et al.*, 2006; Hernandez *et al.*, 2006; Phillips and Dudík, 2008; Wisz *et al.*, 2008; Elith and Graham, 2009; Thorn *et al.*, 2009; Costa *et al.*, 2010) and even with bias present (Phillips *et al.*, 2009; Rebelo and Jones, 2010).

While data used in the modelling of SCI, although scarce, were of high quality, data used in the modelling of IAS had problems typical of *ad-hoc* occurrence data compiled in digital atlas databases (Robertson *et al.*, 2010). In the first case, since they are rare species of high conservation and scientific interest, their degree of prospection is much higher than that with other more common species, specially so in an already well-prospected study area, as in (Marmion *et al.*, 2009). Thus, it is more likely that the geographic range of the species is better reflected by rare species occurrences than with other more common species. These kind of data were the subject of study in Chapter 2. Also in this case, they were compiled and checked record-by-record and it could be safely assumed that all unique occurrence records are correctly identified and georeferenced. Another quality of these data is that they span over the whole realised range of the species; the probability of discovering new populations beyond their current known Extent of Occurrence (EOO) is quite low (Llorenç Sáez, personal communication). Altogether, the level of confidence in the quality of these data is of a much higher degree than with the IAS dataset used in Chapter 3. In this latter case, data were obtained from a digital database encompassing all groups of organisms and species. This database was compiled with semi-automatic digitisation methods and, although quality checks have been made, they are not comparable to a species-by-species and record-by-record check in the case of the SCI dataset.

Spatial autocorrelation among occurrence records is another important aspect regarding data quality in species distribution modelling (Dormann *et al.*, 2007). Spatial autocorrelation may help inflate measures of accuracy for presence-only distribution models (Veloz, 2009) and, as a consequence, model performance may be overestimated. In order to account for autocorrelation, a set of preventive treatments were done to both datasets, SCI and IAS. Instead of a single model per species, multiple models were run from multiple datasets per species; each one containing a different filtered subset of species occurrence records (in each one, occurrence records were guaranteed to be at least at a given euclidean or environmental euclidean distance from each other). This methodology proved effective in removing residual spatial autocorrelation. Of all the models run per species, those with residual spatial autocorrelation were discarded.

Another important aspect of data quality is that of bias or uneven sampling of the geographical and environmental spaces (Phillips *et al.*, 2009). Bias was treated differently for the SCI and IAS datasets. In the SCI dataset case, bias was assumed to be low and thus, of little or no impact on the final models. On the other hand, in the IAS dataset case, bias was known to be high and the target-group background strategy defined by Phillips *et al.* (2009) was applied.

These data particularities determined the modelling strategy taken in Chapters 2 and 3. Knowledge of the quality of the data greatly determines the modelling strategy, as has been shown for both SCI and IAS cases. In Chapter 2, the confidence on the high quality of the occurrence data allowed for safely assuming the resulting models as fairly acceptable and thus, ready for conservation assessment. However, in the case of IAS, in Chapter 3, two situations concurred: problematic fine-resolution data combined with their coarser-resolution counterpart which was assumed to approximate the species distribution at this coarser resolution. This lead us to use this coarser dataset as a second check for model perfomance. A novel cross-scale validation technique was devised to further check the validity of the models against these much coarser resolution data. The study area, Catalonia, is reasonably well prospected for vascular plants at coarse resolutions such as 10-by-10 km (Pino *et al.*, 2005) and, occurrences can be assumed to reflect the true distribution of the species at this resolution. Therefore, we can argue that, once upscaled, finer resolution models should be in accordance with these data at a coarser scale in order to be considered as acceptable. This cross-scale validation confirmed our suspicion on the confidence of the performance measures of fine-resolution models. It resulted in the acknowledgement that, even if apparently valid, fine-resolution models had to be taken with caution since for some species they did not agree with their coarser data.

An obvious general prerequisite is that good quality data is always necessary when modelling species distributions (Robertson *et al.*, 2010). As has been proved, in the case of poor or unknown-quality data, it is convenient to have a target benchmark with which to compare them. However, when good quality data is at hand, we can be more confident in the resulting models and accept them as our best approximations to species ranges. Assumptions are inherent to species distribution modelling and, to some degree, they need to be formulated and accepted (Wiens *et al.*, 2009).

While biodiversity databases need to be improved in quantity and quality (Hortal *et al.*, 2007), in the meantime we need to deal with unknown uncertainty. Most primary biodiversity data present problems of scarcity and quality (Robertson *et al.*, 2010) but this should not lead to inaction (Wiens *et al.*, 2009). When uncertainty is known it can be treated formally and results be given with confidence valuations. When it is unknown we can only try to be as rigorous as possible and make the best educated guesses possible at the time of modelling and analysing results. Failing to do so would render all this wealth of information useless. It is better to have information on a species distribution based on an educated guess rather than not having any information at all. Not using models is not an option and managers must be satisfied with a level of certainty that is *good enough* to move forward (Wiens *et al.*, 2009). Conservation cannot afford waiting for perfect data to be available. Sensible use of the data and modelling techniques can give value to existing biodiversity data in providing good information tools for conservation; as in Bustamante and Seoane (2004).

Environmental data

Spatially exhaustive environmental data are the second source of input data for species distribution models (Peterson *et al.*, 2011). Their relevance for the species ecological requirements and constraints, and their completeness are important aspects for obtaining good distribution models (Elith and Leathwick, 2009). We need reliable, geographically comprehensive, well-documented datasets on environmental data.

Climatic variables are important in determining the coarse distribution of species while finer-grained habitat structure and biotic interactions determine their fine-scale distribution (Grinnell, 1917; Soberón and Nakamura, 2009). Variables relating to climate, topography and land cover are often easily available in developed countries, while variables relating to habitat structure and biotic interactions are very scarce (Peterson *et al.*, 2011). An objective of this dissertation was to explore the generation of range maps at a resolution useful in conservation planning (1 km). Although finer-resolution maps would allow for planning and management decisions more attuned with existing data, both species occurrences and environmental predictors, allowed us to reach the 1 km target.

In each case, SCI and IAS, we used the set of 19 bioclimatic variables defined by Nix (1986) and widely used by the species distribution modelling community. These variables are a combination of annual trends, seasonality and extreme conditions relevant to species physiological tolerances. In both cases, we enriched the predictor set with other non-climatic predictors thought to be relevant. This dissertation deals with predicting distributions and ranges of species rather than explaining which factors or variables determine their distribution. Although the set of environmental predictors used, both in modelling SCI and IAS, presented collinearity issues, it was not necessary to remove collinearity since it has been shown not to affect Maxent predictive performance (Kuemmerle *et al.*, 2010).

Data availability and usability

Primary biodiversity data. For primary biodiversity data, the desired scenario of seamless data availability and access mentioned in the Introduction (Section 1.5) has not been achieved yet. However, several initiatives are clearly going in that direction, the most prominent one being that of the Global Biodiversity Information Infrastructure or GBIF (GBIF, 2013a). GBIF is actively working with partners to achieve interoperability and data integration (GBIF, 2011). GBIF achieves interoperability with data providers by accepting data which is transferred or automatically harvested by software tools through the use of several standards (GBIF, 2013b) and, with data consumers, by offering them different web services. For instance, occurrence records can be automatically retrieved through its *occurrence record data service* in Darwin Core format (Biodiversity Information Standards - TDWG, 2013; GBIF, 2013c). This way, primary biodiversity data can be harvested from a myriad of data providers all over the world and redistributed from a centralised data gateway using standardised web services (Wieczorek *et al.*, 2012). Apparently then, the technical development side of interoperability seems pretty well defined and solved. However, the deployment side proceeds at a slower rate. In the case of Catalonia, for example, GBIF assisted the data provider, the University of Barcelona, in setting up two servers which were intended to automatically harvest the data and transfer them to GBIF. In reality, however, these servers were only partially set up and there is still much work to do in order for them to be completely operational (Biodiversity Data Bank of Catalonia, personal communication). As a result, these data were not available through GBIF in an interoperable manner but only through the web portal of the Biodiversity Data Bank of Catalonia (Font *et al.*, 2009).

Besides these operational problems, GBIF data still present other more important shortcomings (partially derived from the operational ones): a) the large amount of data that is still locked away in data providers, whether analogical documents, archives or collections or, as we have seen, unreachable databases, b) the loss of information for certain kinds of data such as observations from vegetation plots since the Darwin Core GBIF does not accomodate information on the co-occurrence of taxa (Dengler *et al.*, 2011) and, c) lack of metadata information on the quality of the georeferences on many occurrence records, or its inconsistency, which renders them unusable for distribution modelling. Thus, GBIF is not a complete solution to data provision in biodiversity studies yet. The SCI dataset used in Chapter 2 and the IAS dataset used in Chapter 3 were examples of this. The former pertained to the set of occurrence data still in analogic format (they were compiled from analogic data sources and specifically digitised for this dissertation) and the latter to the set of unreachable databases via GBIF (they were obtained directly from the data provider on a person-to-person interaction).

Global databases like GBIF are not easy accomplishments, they require an enormous amount of resources and international coordination among very disparate data sources. However, if we are ever to be able to analyse biodiversity distribution and conservation globally it is imperative to compile and organise data into readily accessible and standardised databases.

Environmental data. Contrary to data on species occurrences, there exists no global initiative similar to that of GBIF. There is no single gateway to environmental datasets available for the different continents, countries, regions, etc. As we have seen above, modellers need to compile and prepare environmental layers, often from different data providers, for each specific study, a non-trivial task consuming worthy hours of research time (Franklin, 2009). Such an initiative would be very welcome by the research community and by technical staff in governmental and non-governmental organizations. Currently, these initiatives exist at the regional, national and supranational (*e.g.* the INSPIRE initiative in Europe (European Commission, 2013)) levels but without a global coordinating umbrella organization.

As a consequence of the growth of spatial modelling techniques and remote-sensing technologies there is an increasing availability of high-quality digital environmental spatial layers (Peterson *et al.*, 2011). However, this information exists in a very fragmented way. While there are some global datasets such as WorldClim (Hijmans *et al.*, 2005), for many countries and regions there exist more detailed layers (*e.g.* Ninyerola *et al.* (2010) in the case of the Iberian peninsula). In this dissertation, we faced two different situations when modelling SCI and IAS due to the differences in data availability for the two study areas. In the case of SCI, the study area was the Western Mediterranean, which comprises regions of Europe and Africa. For climatic variables we used the WorldClim dataset (Hijmans *et al.*, 2005) which is global in scope. For the soil variable, pH, this was not the case. Often, environmental data is only available for a given region, which was the case for the pH variable used when modelling SCI. To encompass the whole of our study area we had to combine data on pH from two different sources: the European Soil Data Centre (European Soil Data Centre, 2012) and the Harmonized World Soil Database (FAO/IIASA/ISRIC/ISSCAS/JRC, 2012). In the case of IAS, our study area was Catalonia and since all variables available for the whole of the area, no need arose to combine different datasets.

Modelling tools and maps for conservation

Species distribution modelling

Current advances in statistics, computer science and information technology along with the Internet has made possible the emergence of all kinds of modelling algorithms and software packages (Guisan and Zimmermann, 2000). The open source movement has also played a major role in opening the algorithms to public scrutiny and test with the Comprehensive R Archive Network (R Core Team, 2012) a prominent example. We cannot afford to ignore this enormous wealth of resources and state-of-the art tools which are available for planning and managing the conservation of biodiversity (Wiens *et al.*, 2009). These modelling tools implement a whole range of different types of algorithms based on different knowledge domains, from classical regression to genetic algorithms and machine learning (see Figure 1.5). The available options to the researcher are enormous in scope, which makes it very difficult, if not impossible, to master them all. Fortunately in recent years there has emerged a growing body of literature comparing the performance of different methodologies for different research purposes (*e.g.* Elith *et al.* (2006); Marmion *et al.* (2008); Elith and Leathwick (2009)), a recognized shortcoming just a few years ago (Guisan and Zimmermann, 2000).

Biodiversity conservation through species distribution modelling is an interdisciplinary approach including mainly statisticians, biologists and computer scientists. No single researcher can master the whole span of modelling techniques and the myriad of considerations that have to be taken into account. Lately, a new modelling trend has emerged: *ensemble* forecasting. It consists in the parallel use of many different algorithms and the reaching of a sort of *consensus* on the results to give a final distribution model (Araújo and New, 2007). Researchers advocating its use recognize that further research needs to be done in this respect (Grenouillet *et al.*, 2011). In this dissertation this option has not been chosen, partly due my reluctance to mix different results from many methodologies. If the results from the different algorithms are not well sorted out, the best ones might get diluted with the worst (Peterson *et al.*, 2011), preventing a better result had the correct choices been made and the most appropriate algorithm for the situation at hand been used. We have opted for a model, Maxent (Phillips *et al.*, 2006), known to perform well in the data situations dealt with in this dissertation (Elith *et al.*, 2006; Pearson *et al.*, 2007; Rebelo and Jones, 2010; O Donnell *et al.*, 2012) rather than mixing it with models known to be poorer performers with the situation at hand, a solution recognized by Peterson *et al.* (2011). Our results have also confirmed the usefulness of Maxent as a tool for modelling species distributions from data with problems of scarcity and bias.

Range or distribution maps for conservation assessment and planning

Range and distribution are two terms used in indistinctly much of the species distribution modelling literature; only in a few papers are they used with different meanings (*e.g.* Márcia Barbosa *et al.* (2012); Pineda and Lobo (2012)). In these cases, range maps are used as synonyms for the species extent of occurrence or EOO (usually drawn by experts or automatically delineated with the convex hull method from occurrence points) while distribution maps represent the species area of occupancy or AOO. Species are not uniformly spread all over their EOO but normally present internal discontinuities (Ladle and Whittaker, 2011). Range maps tend to underestimate or simply ignore these discontinuities (Gaston and Fuller, 2009). The species EOO is the area that lies within the outer boundaries of the species occurrence while the AOO is that which is actually occupied within the EOO (Lomolino *et al.*, 2004; Gaston and Fuller, 2009).

Mapping the distribution of biodiversity is key to conservation action (Balvanera *et al.*, 2001; Roura-Pascual *et al.*, 2009). Range maps, if interpreted as EOO, do not provide a solid basis for conservation planning (Ladle and Whittaker, 2011). However, in the absence of better information, EOO size is an accepted measure for species extinction risk assessment (IUCN, 2001). AOO, in contrast, does reflect the patchiness of species distributions determined by the heterogeneity of the available environment. Both measures, though EOO to a lesser degree, are scale-dependent (Hartley and Kunin, 2003; Gaston and Fuller, 2009). Fine-resolution species distribution models, *e.g.* 1-by-1 km, offer a robust measure of AOO and are cost-effective tools for deriving information valuable to the conservation of rare species (Jiménez-Alfaro *et al.*, 2012). Nevertheless, in order to obtain realised species distributions for conservation assessment, absence data is needed. With presence-only data, the outcome of the modelling process are potential distributions (Soberón and Nakamura, 2009). However, when species are known to be well-surveyed in a given study area, such as the case for SCI in Chapter 2, it is possible to offer good approximations to AOO by combining information on species EOO and distribution models. Continuous probability maps of potential distributions can be turned into binary maps of suitable/unsuitable areas by using an appropriate threshold such as the minimum training presence value (Pearson *et al.*, 2007).

When the species occurrence data available are known to be spread over the whole geographical area occupied by the species, the suitable area within the EOO can be taken as our best approximation to its realised distribution. Both types of maps, potential and realised distributions are very useful in assessing species protection status and extinction risk. On the other hand, IAS distribution models (Chapter 3) can be interpreted as maps of potential threat to biodiversity, specially in protected areas. Both types of maps, values (SCI, Chapter 2) and threats (IAS, Chapter 3) are invaluable information products for conservation management and planning (Rodrigues *et al.*, 2003; Roura-Pascual *et al.*, 2011). They can be overlaid onto maps of protection areas boundaries (Chapter 4) in order to: a) determine gaps in the protection of species of conservation interest (as in Araújo *et al.* (2007)) and b) determine the risk of potential invasions (as in Edwards *et al.* (2007)). Furthermore, maps of potentially suitable areas are of major interest in eventual relocation projects for the preservation of rare species, as in Fei *et al.* (2012). In this case, identifying those areas within existing protected areas can be vital. The combination of species distribution modelling and information systems, with a careful attention to data, provide a powerful framework for conservation planning worth developing and improving (Rodríguez *et al.*, 2007).

Organizing data on biodiversity protection

The most effective way to conserve biodiversity is to maintain native species in natural ecosystems (Balmford, 1996). Protected areas are effective in the protection of biodiversity as they counteract the disappearance of biodiversity (Rodrigues *et al.*, 2003; Butchart *et al.*, 2012). Monitoring their coverage area over time will give an indication on how well biodiversity is being protected since protected area coverage is considered a surrogate indicator of the protection of biodiversity (Chape *et al.*, 2005; United Nations Environment Programme, 2009; Jones *et al.*, 2011). Protected area coverage is one of the indicators of environmental sustainability used by the UN Millenium Development Goals (United Nations Development Programme, 2009) and its measurement relies on the data held in the World Database of Protected Areas (WDPA) of UNEP s World Conservation Monitoring Centre (WCMC). WDPA (IUCN-UNEP, 2013) is fed with data sent by national and regional governments around the world. In order to effectively monitor biodiversity protection, we need comprehensive and well-structured information on protected areas boundaries which takes into account historical boundaries. Otherwise, the indicator cannot be calculated and monitored over time.

The protected areas information system presented in Chapter 4 provides a model for tracking historical changes in boundaries. After examining several relevant databases (see Chapter 4) we found that none allowed for historical information, except for WDPA (although not directly visible and accessible in their web portal). Historical information is a much needed feature if WCMC is accountable for providing information on protected area coverage over time. Regional and national databases should accomodate this kind of information since they are the ones feeding WDPA. The system presented in Chapter 4 actually goes one step further in that it allows also the handling of the changes made in boundaries along the legal process of approval. This kind of information, together with the actual claims and reasons that led to them, can play an important part in future research on the socio-economical reasons that govern the delineation of protected area boundaries. Such research can uncover valuable information on social and economical patterns which need to be taken into account by decision-makers in public environmental administration bodies. A big challenge for this is the lack of staff time dedicated by governmental bodies into entering and curating this information.

Indedd, one of the main obstacles for the successful development and deployment of conservation information systems is not of technical nature but managerial and organizational. Factors such as user participation, perceived usefulness, professionalism and top management support determine the successful implementation of an information system (Uran and Janssen, 2003; Díez and McIntosh, 2009). The real challenge lies in changing or adapting existing organizational workflows and personnel to the use of such novel technologies. Even though they provide clear advantages, existing habits, personal interrelations and, above all, lack of clear direction and strategic planning by an unstable, always changing directive staff, greatly hinder its effective use. Its widespread deployment and use belongs more to the realm of organizational engineering rather than software engineering.

5.2 Conclusions

This final section summarizes and highlights the conclusions of each Chapter.

Chapter 2

2.1 Species distribution modelling is a valid tool for generating valuable information for conservation management when dealing with rare species in well-surveyed areas.

2.2 The use of well-known Extents of Occurrence (EOO) with maps of Potentially Suitable Areas (PSA) offers a way to discern between an approximation of realised and potential distributions.

2.3 This dissertation provides probability models and range maps for seven rare endemic vascular plants of the western Mediterranean for the first time and a first quantitative assessment of their realised and potential distributional areas, their degree of protection and information useful to assess the extent to which they are threatened. The estimated protected fractions ranged from 17.9% to 27.6% for their Area of Occupancy (AOO), from 15.3% to 22.5% for their EOO and from 19.9% to 27.9% for their PSA.

2.4 Except for one case, the PSA for the set of studied species are much larger than their corresponding AOO and EOO. This confirms the previous expert view, which was unsupported by data that these species are much more restricted in range than the area that appears to be suitable for them; their EOO to PSA ratio ranges from 0.091 to 0.713 and their AOO to PSA from as low as 0.029 to as high as 0.417. Although not explored in this dissertation, this is probably due to a combination of historical phylogeographical factors and to the absence of several environmental or biotic predictors which could contribute to determining the species spatial distribution.

Chapter 3

3.1 Casual observations at fine resolution in biodiversity atlases or databases have the potential to generate continuous species distribution maps through species distribution modelling, providing powerful tools for conservation management and planning. However, it may be impossible to obtain them for many species because of scarcity and strong biases in the data.

3.2 Although high validation scores can be obtained when modelling such data, there is a risk that the distribution maps reflect the data distribution rather than the true species distribution. Cross-scale validation of the data with species distribution information at a coarser scale appears to be a consistent protocol to test the validity and robustness of fine-resolution models and thus to make them much more reliable for decision-makers in conservation.

3.3 Fine-resolution maps can be derived from biodiversity atlases with data scarcity, bias and autocorrelation. Bias, and specially autocorrelation, treatments can help to remove residual spatial autocorrelation in models. However, if no independent set of data is available to further validate them, results should be viewed with caution. Only four out of ten modelled species delivered acceptable models. Their best models Area Under the Curve, AUC_{1k}, ranged from 0.76 to 0.94 and their upscaled, AUC_{10k} from 0.70 to 0.93.

3.4 When good coarser scale data are available, cross-scale validation appears to be effective in assessing the robustness of the models. Otherwise, new field surveys may be the only option if reliable fine-scale maps are needed.

Chapter 4

4.1 We have presented an information system for helping public administrations in dealing with the complex and interconnected set of information regarding protected areas, administrative processes and legal texts. For any type of legally defined protection category, it can handle historical information, including boundaries, on the administrative processes involved in protected-area declaration, modification and termination. Thus, it can monitor protected-area coverage over time, a surrogate indicator of biodiversity protection. Regional and national governments can also benefit from such a system for feeding data to reference databases such as the World Database on Protected Areas and the European Common Database on Designated Areas.

4.1 This system is already in use as a tool for handling protected area boundaries in the corresponding body of the Catalan administration (*Generalitat de Catalunya*). Currently it holds data on 410 protected areas.

5.3 Further research

Some suggestions for further research are as follows:

1. Applied and methodological research

   a) Further explore, apply and extend to the Mediterranean basin, the methodologies developed in Chapters 2 and 3 to analyse: a) the protection of species of conservation interest, b) the threat posed by alien invasive species and c) the range size of species.

   b) Mass-apply the methodology developed in Chapter 3 to all vascular plant species present in the Biodiversity Data Bank of Catalonia in order to obtain fine-resolution species distribution maps and use them for deriving species richness maps. Explore this as a new technique for evaluating the validity of occurrence data in biodiversity databases and for directing future survey efforts.

   c) Explore new methodologies for true downscaling of occurrence data, *i.e.* generate fine resolution maps out of both coarse and fine resolution data rather than using coarser data only for validation.

2. Conservation Information systems

   a) Design and develop an information system which automates the methodologies developed in Chapters 2 and 3.

   b) Enhance the protected areas information system (Chapter 4) with information on the conservation plans of protected areas.

   c) Integrate *items 2a* and *2b* into a single system for conservation assessement.

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Appendix A

Distribution model maps of Species of Conservation Interest

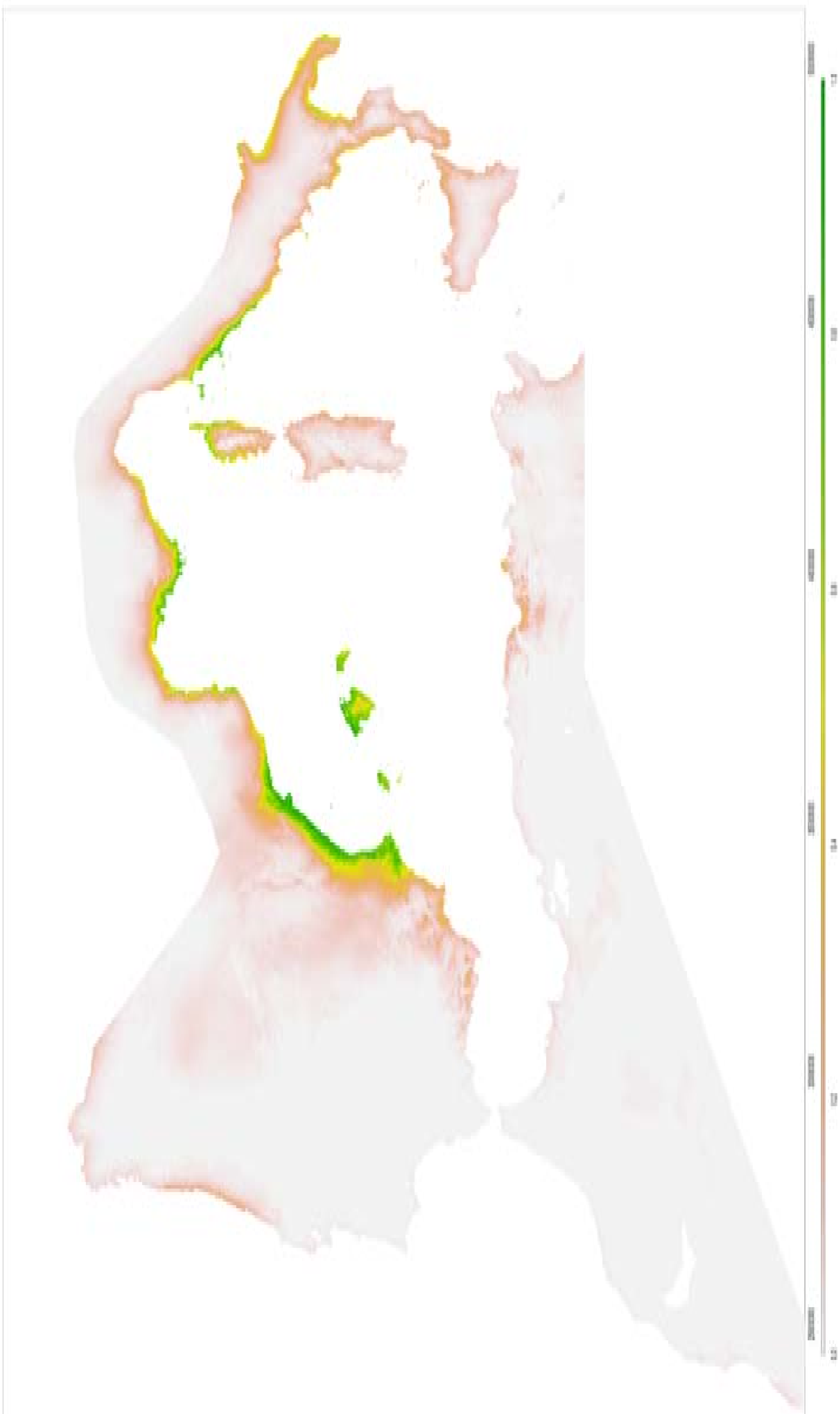


Figure A.1: Distribution model of *Asplenium majoricum* Litard.

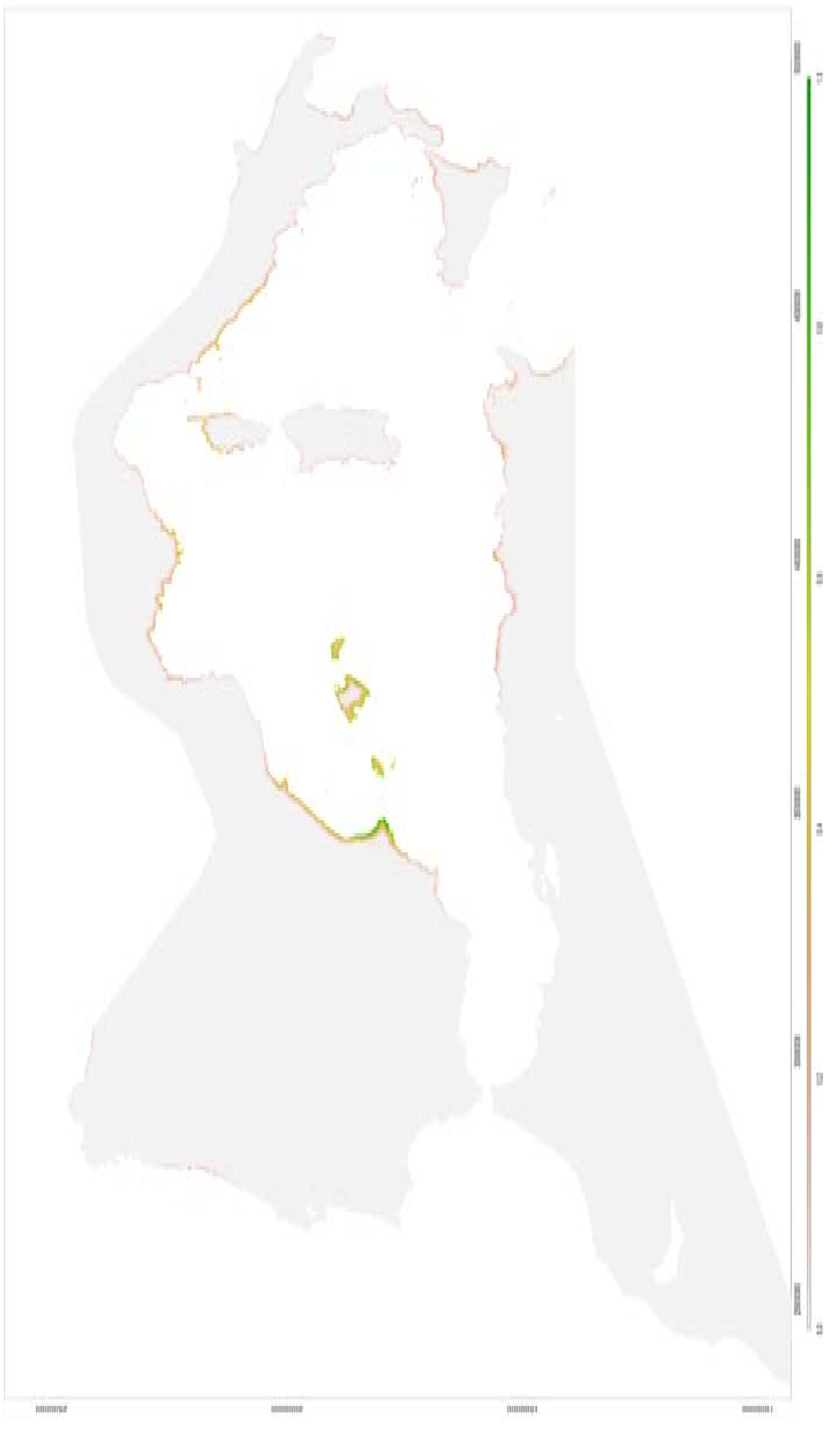


Figure A.2: Distribution model of *Carduncellus dianius* (Webb) G. López

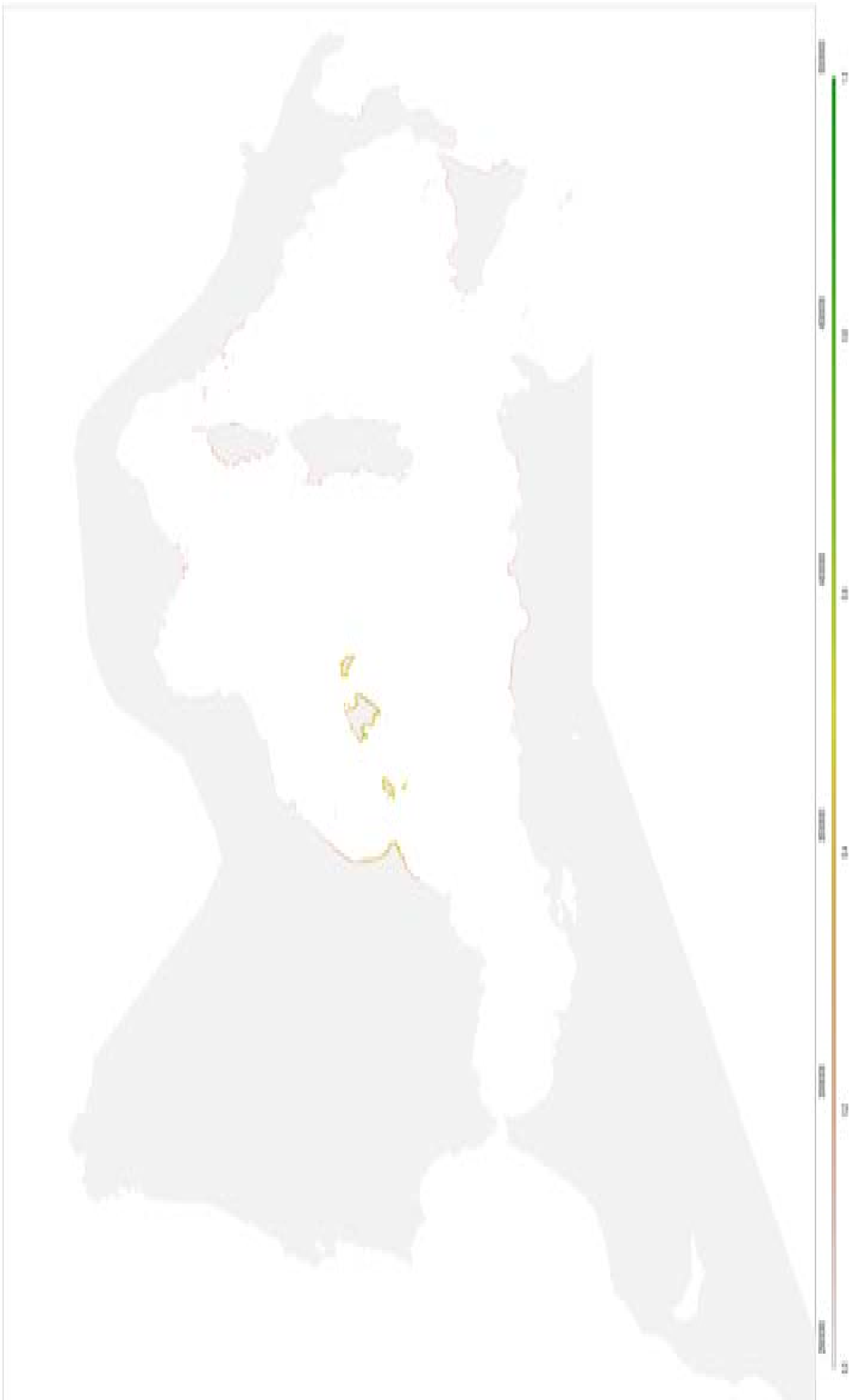


Figure A.3: Distribution model of *Diplotaxis ibicensis* (Pau) Gómez Campo

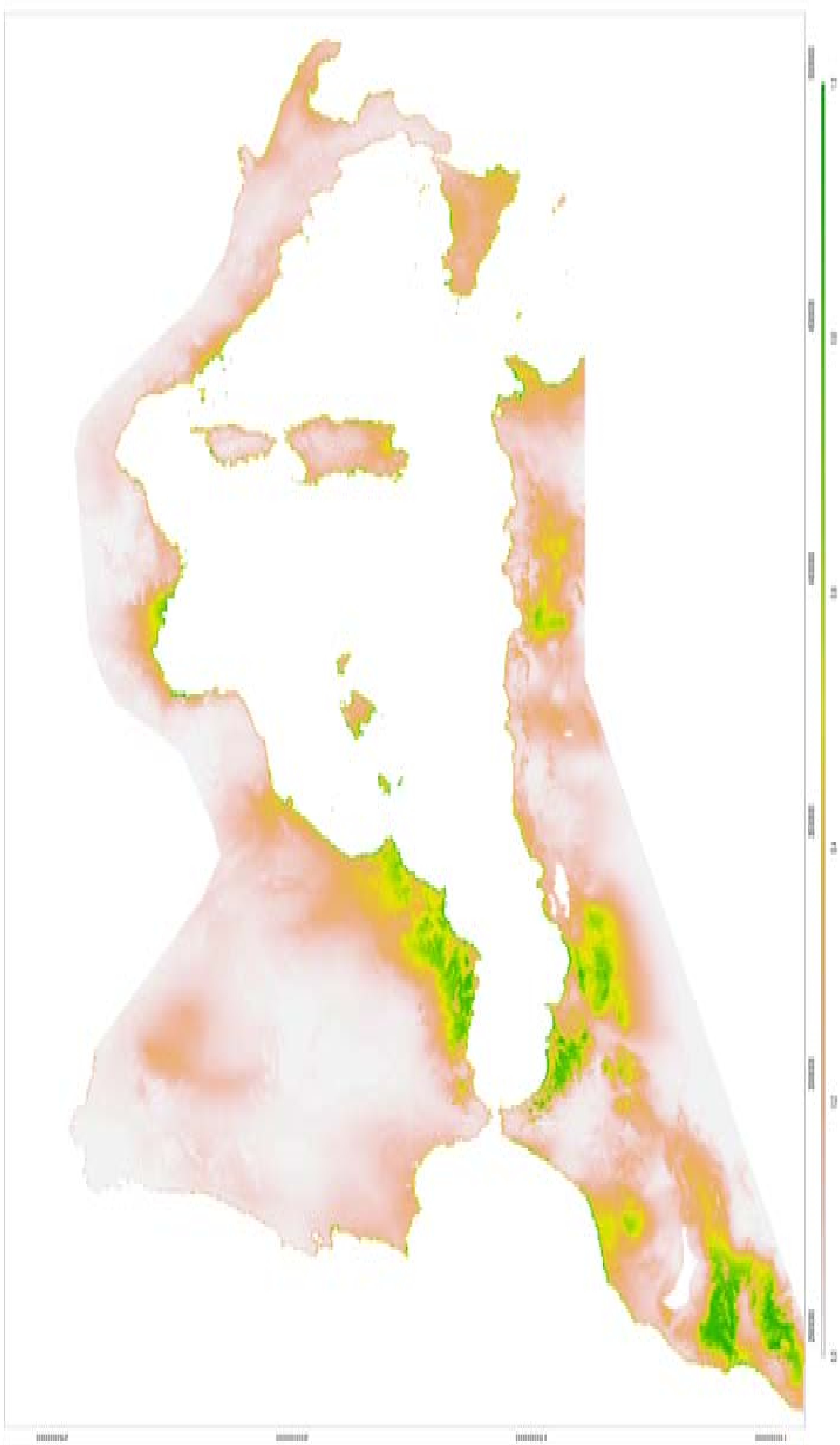


Figure A.4: Distribution model of *Euphorbia squamigera* Loisel.

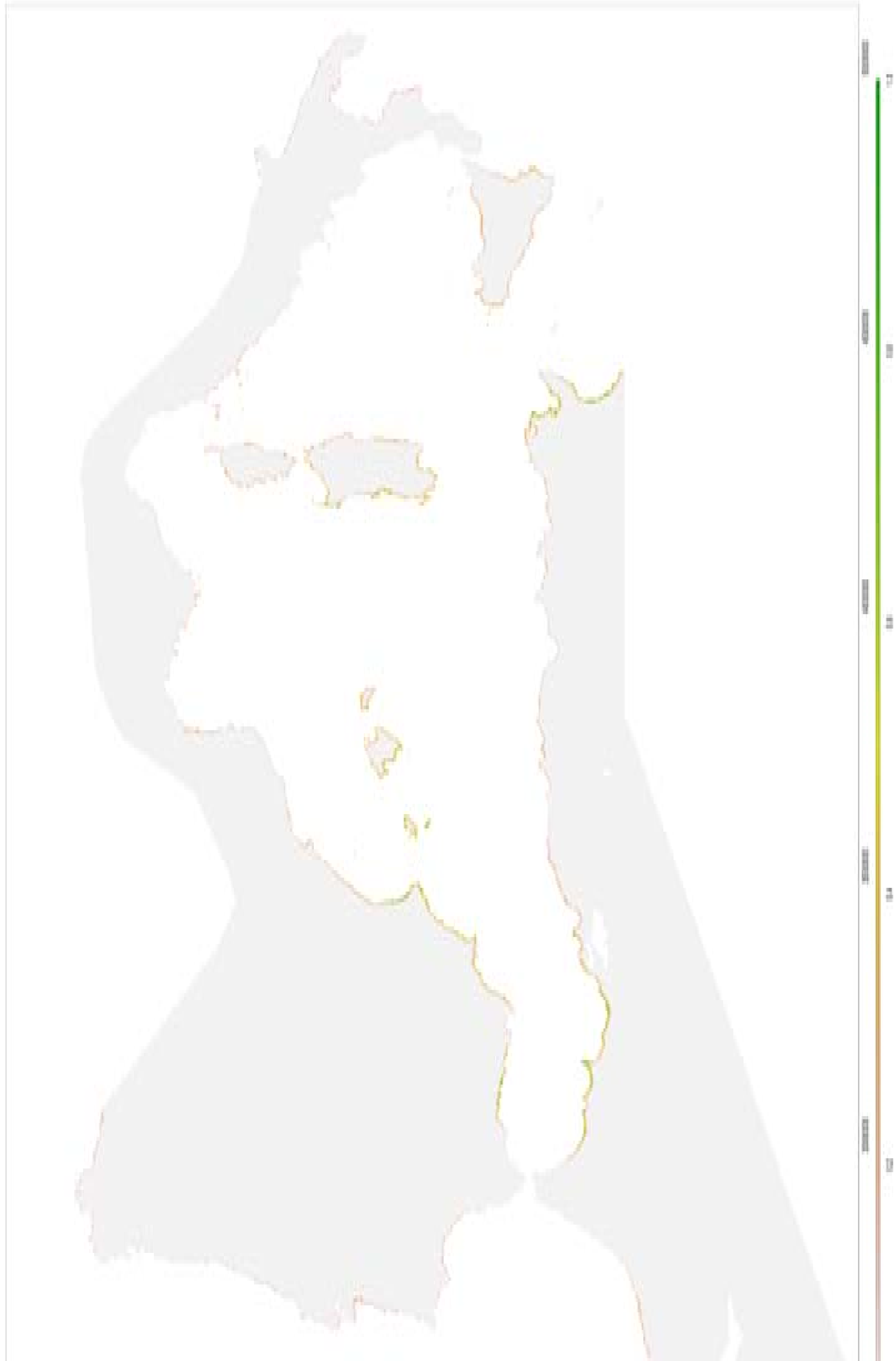


Figure A.5: Distribution model of *Helianthemum caput-felis* Boiss.

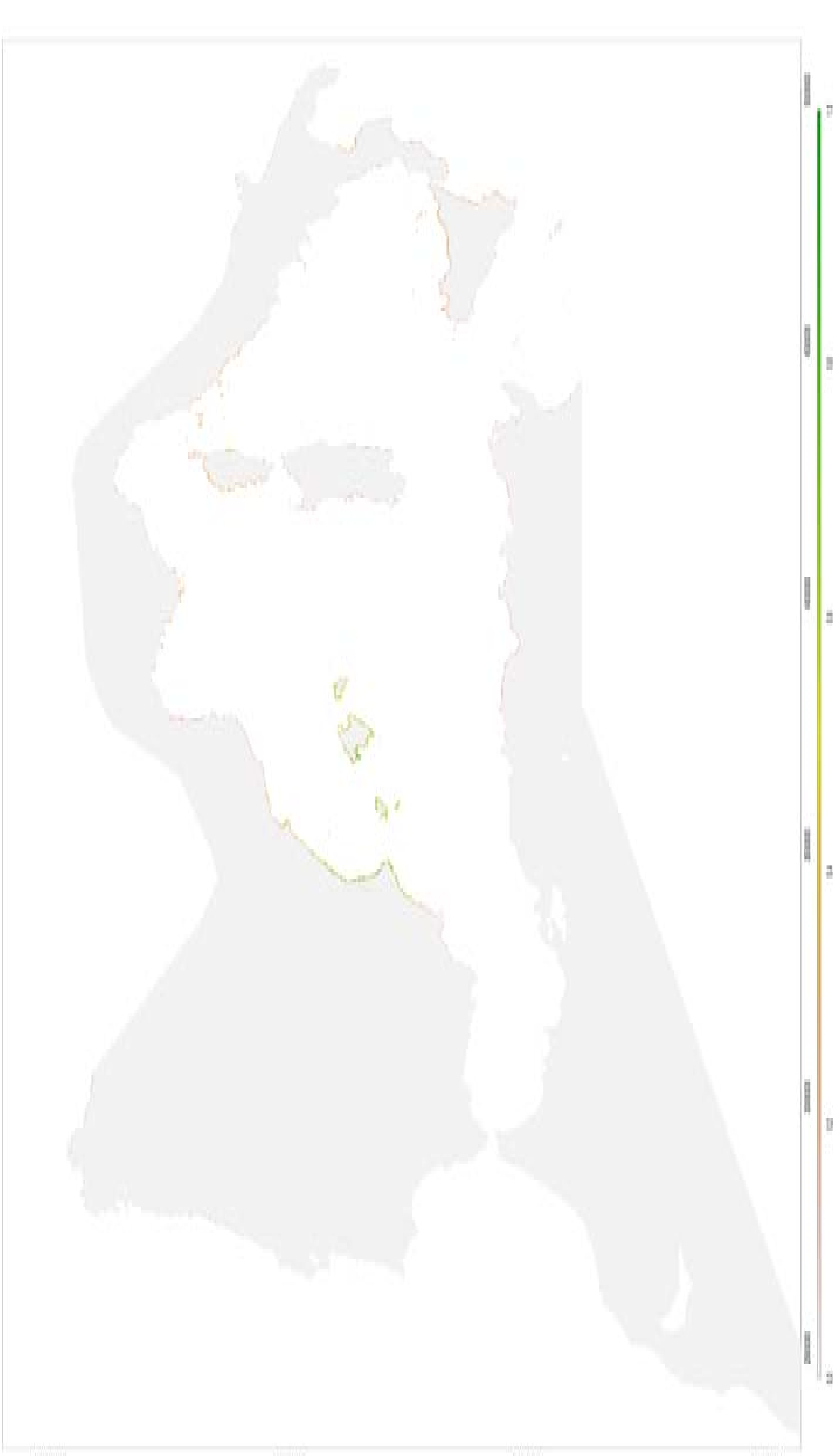


Figure A.6: Distribution model of *Medicago citrina* (Font Quer) Greuter

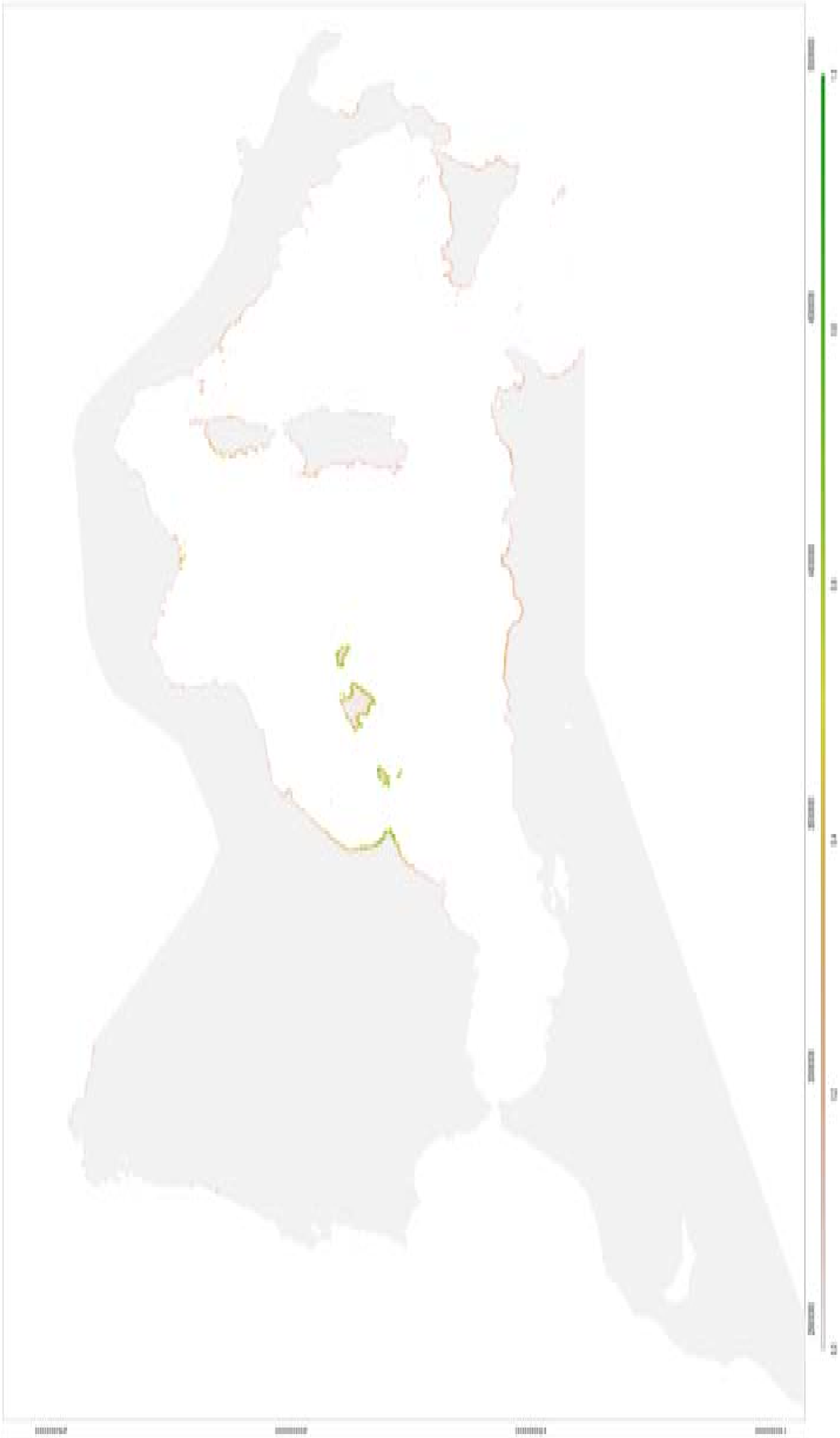


Figure A.7: Distribution model of *Silene hifacensis* Rouy ex Willk.

Appendix B

Protected range maps of Species of Conservation Interest

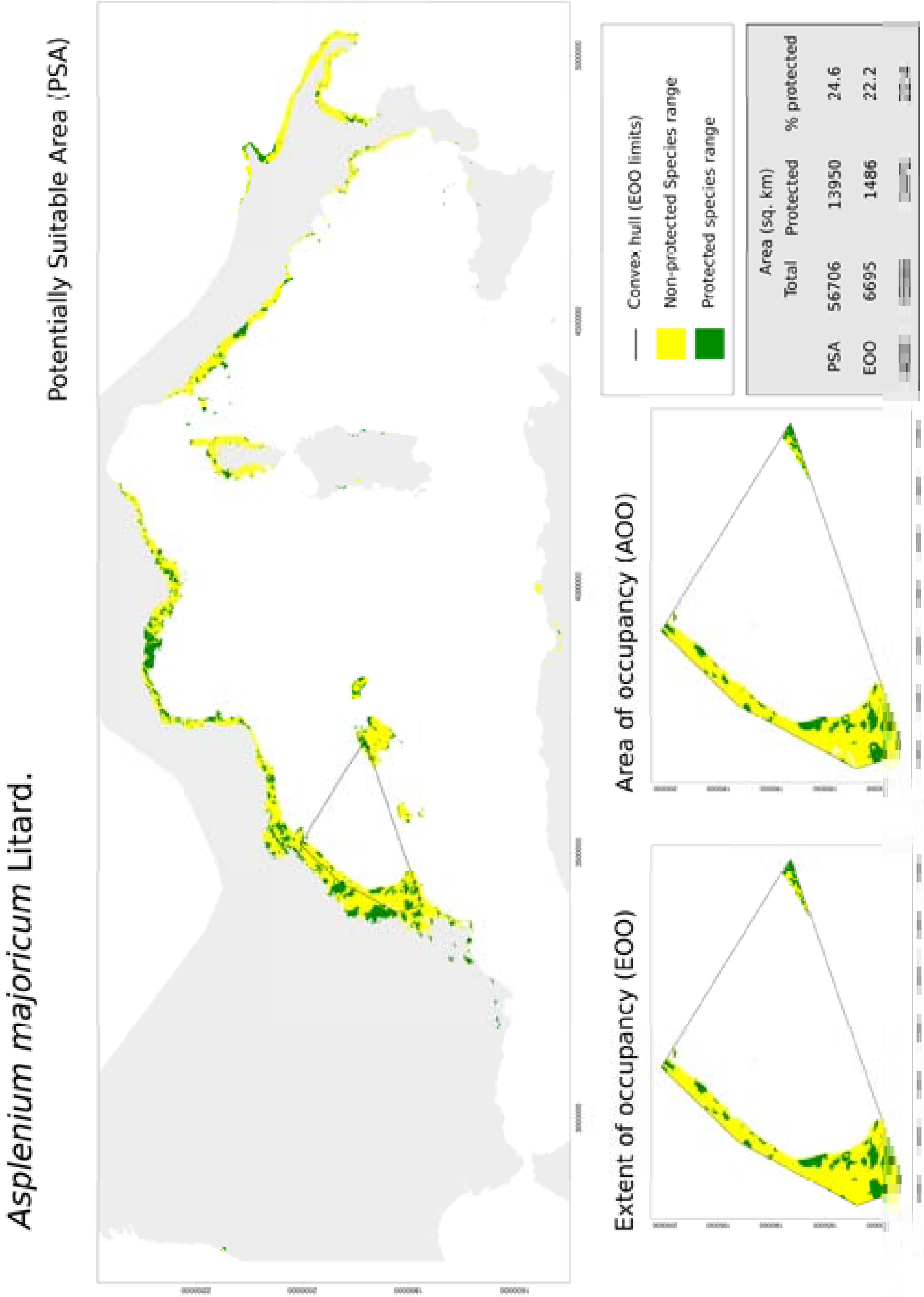
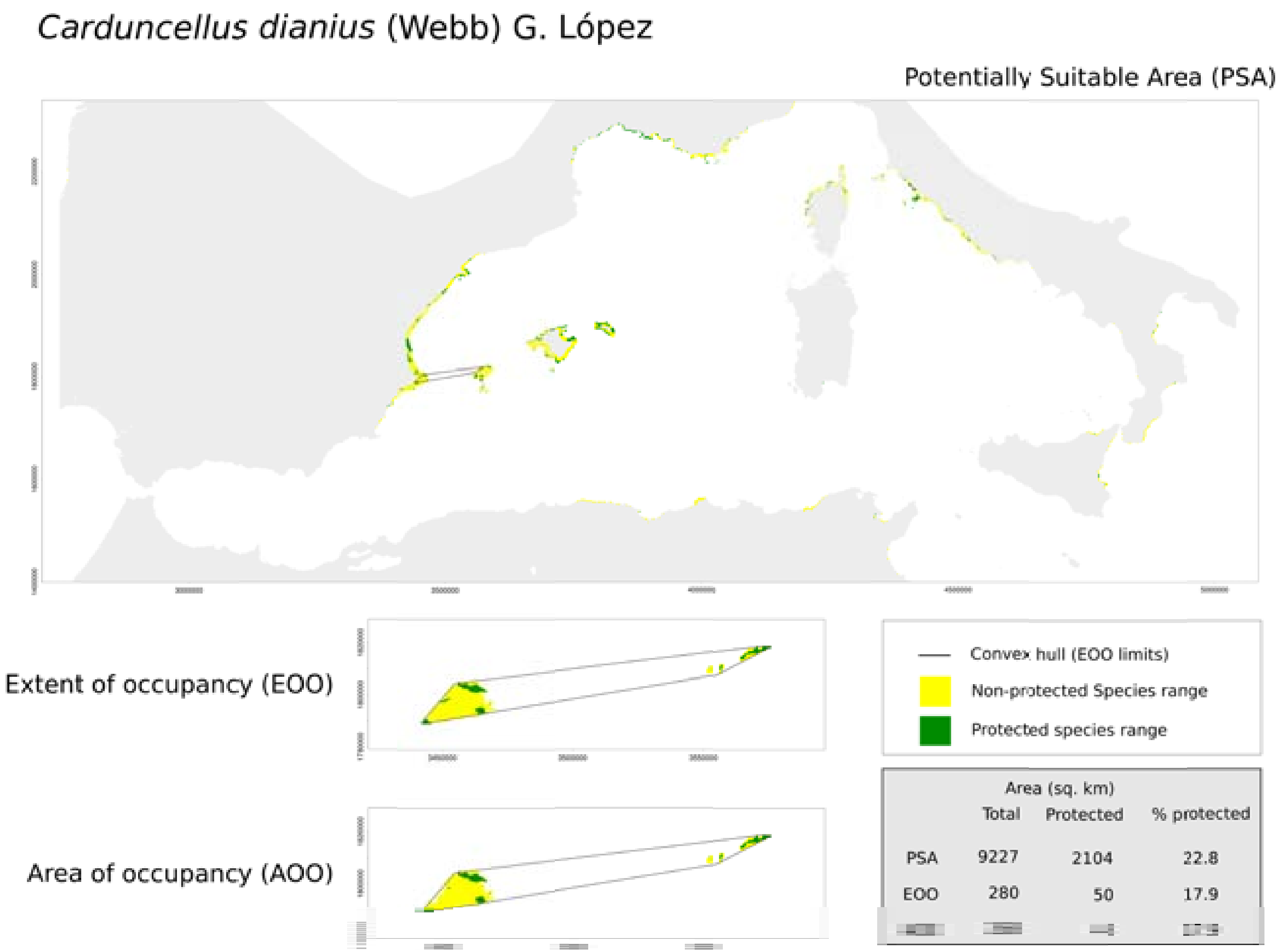


Figure B.1: *Asplenium majoricum* protected range



	Area (sq. km) Total	Protected	% protected
PSA	9227	2104	22.8
EOO	280	50	17.9
[illegible]	[illegible]	[illegible]	[illegible]

Figure B.2: *Carduncellus dianius* protected range

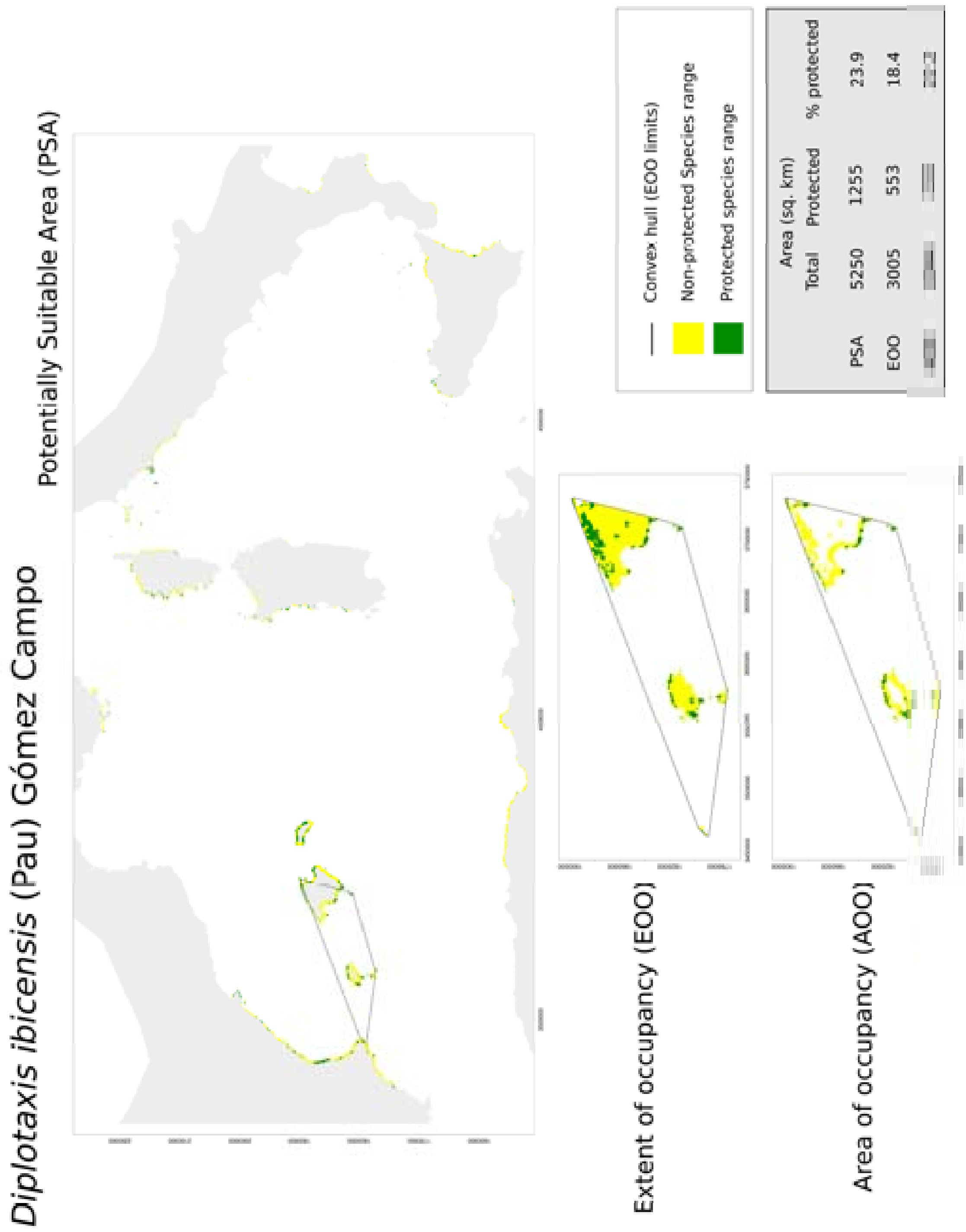


Figure B.3: *Diplotaxis ibicensis* protected range

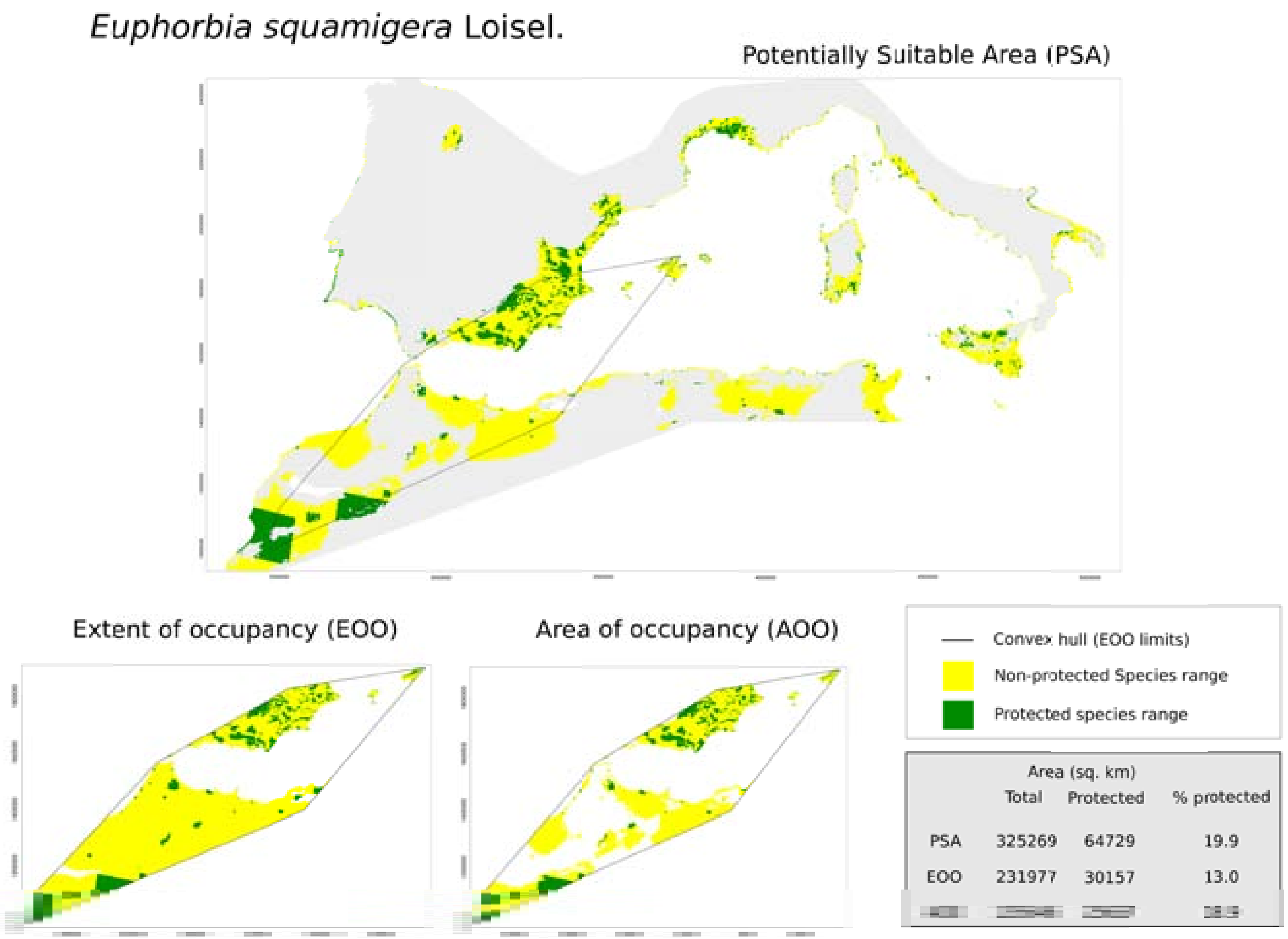


Figure B.4: *Euphorbia squamigera* protected range

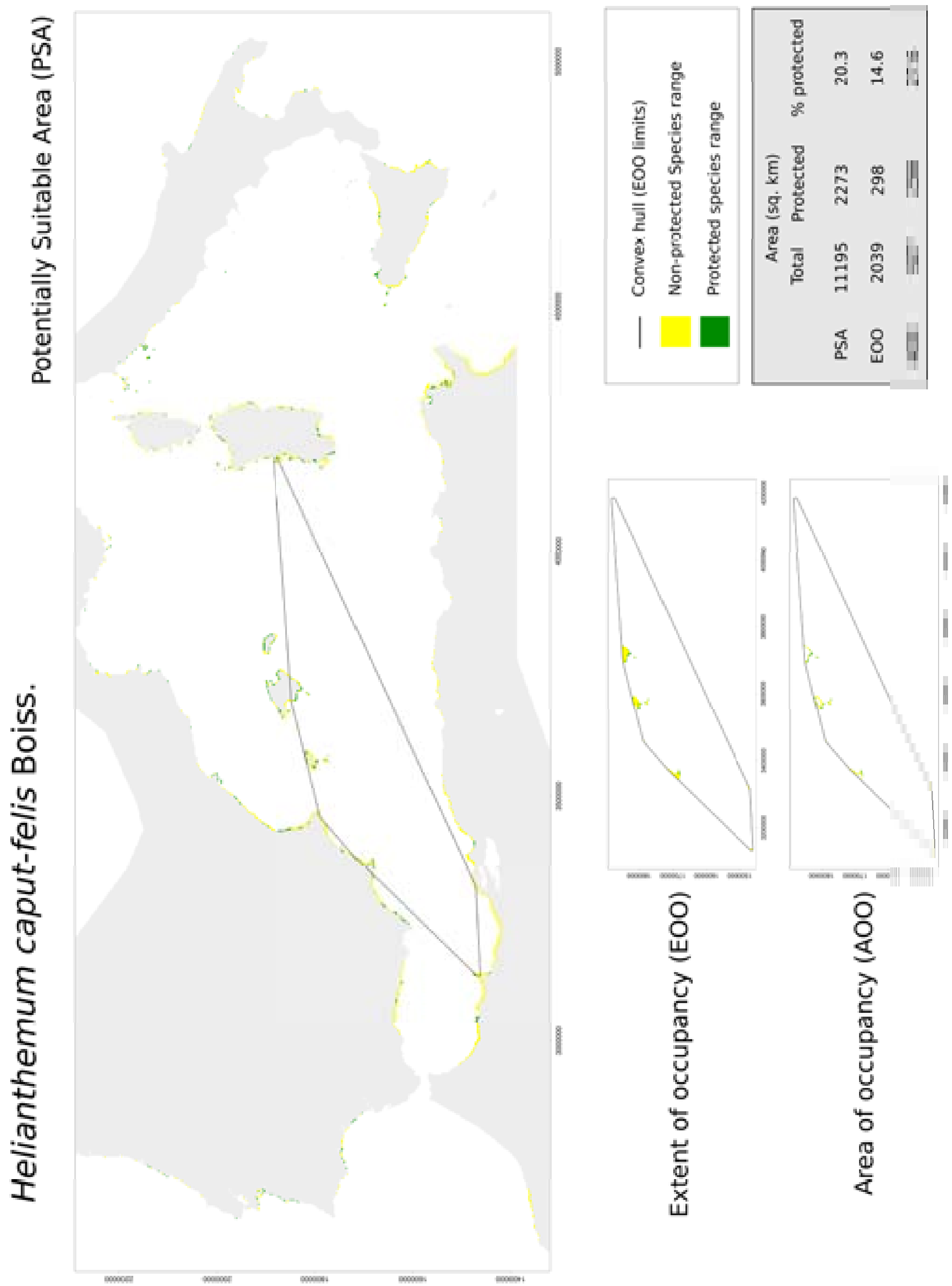


Figure B.5: *Helianthemum caput-felis* protected range

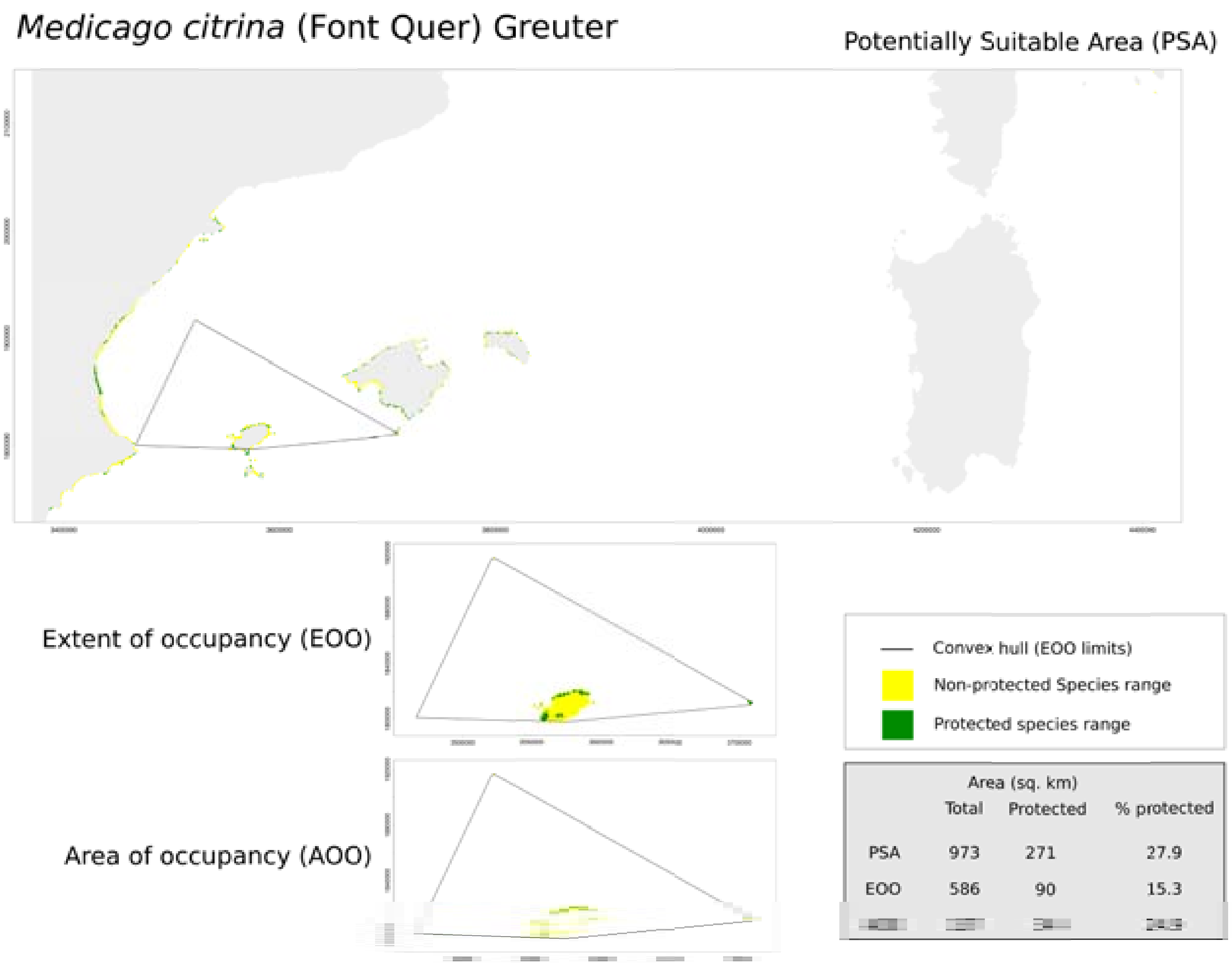


Figure B.6: *Medicago citrina* protected range

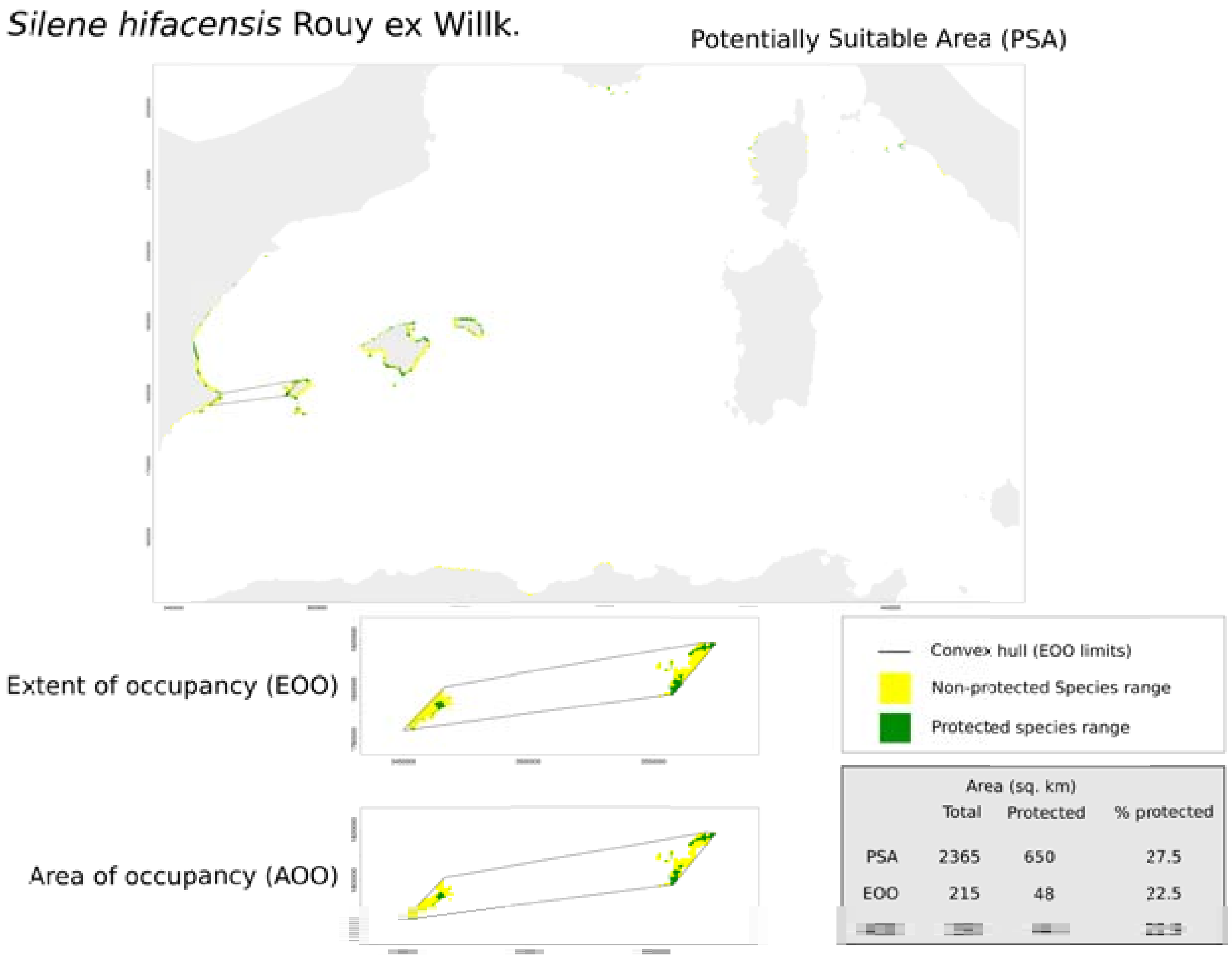


Figure B.7: *Silene hifacensis* protected range

Appendix C

Protected range sizes of Species of Conservation Interest

How to interpret these results All calculations were done at 1-km resolution. A land mask was used in order to exclude sea pixels. In this mask, all 1-km grid cells that intersected with land where considered as land, however small its intersection was. Marine-only sites may appear in the tables since, at coastal areas, many 1-km grid cells share land and sea (besides, in the Natura 2000 shapefile, marine sites are not individualized and many sites are a single polygon comprising terrestrial and marine areas). Since all 1-km cells intersecting any given protected site are considered, the PA cells column in each table shows an area in square km which is always greater than the actual site area. Results are grouped per species and there are up to four tables per species. However, some tables may be missing depending on the species range maps:

Tables of Potentially Suitable Areas protection by Natura 2000 protected areas.

These tables provides the results of overlaying the Potentially Suitable Areas (PSA), as defined in the article, with the Natura 2000 sites.
Columns: Code: Natura 2000 official site code (field SITECODE in Natura 2000 shapefile), Name: Natura 2000 official site name (field

SITENAME in Natura 2000 shapefile), PA cells: Number of 1 km cells which intersect with the site polygon, PSA cells: Number of suitable 1 km cells which intersect with the site polygon, Perc. PSA: Percentage of PSA cells with respect to PA cells .

Tables of Species EOO and AOO protection by Natura 2000 protected areas.

These tables provide the results of overlaying the Extent of Occurrence (EOO) and Area of Occupancy (AOO), as defined in the article, with the Natura 2000 sites.

Columns: Code: Natura 2000 official site code (field SITECODE in Natura 2000 shapefile), Name: Natura 2000 official site name (field SITENAME in Natura 2000 shapefile), PA cells: Number of 1 km cells which intersect with the site polygon, EOO cells: Number of 1 km cells which intersect with the species EOO polygon (sea excluded) and with the site polygon, Perc. EOO: Percentage of EOO cells with respect to PA cells , AOO cells: Number of 1 km cells which intersect with the species AOO (as defined in the article) and with the site polygon, Perc. AOO: Percentage of AOO cells with respect to PA cells .

Tables of Potentially Suitable Areas protection by North African protected areas.

These tables provide the results of overlaying the PSA, as defined in the article, with the protected areas of North Africa.

Columns: Code: Site s identification code (field wdpaid) in the World Database of Protected Areas (WDPA), Type: Protection category (field desig_eng) in the WDPA, Name: Site name (field name) in the WDPA, PA cells: Number of 1 km cells which intersect with the site polygon, PSA cells: Number of suitable 1 km cells which intersect with the site polygon, Perc. PSA: Percentage of PSA cells with respect to PA cells .

Tables of Species EOO and AOO protection by North African protected areas.

These tables provides the results of overlaying the EOO and AOO, as defined in the article, with the protected areas of North Africa.

Columns: Code: Site s identification code (field wdpaid) in the World Database of Protected Areas (WDPA), Type: Protection category (field desig_eng) in the WDPA, Name: Site name (field name) in the WDPA PA cells: Number of 1 km cells which intersect with the site polygon, EOO cells: Number of 1 km cells which intersect with the species EOO polygon (sea excluded) and with the site polygon, Perc. EOO: Percentage of EOO cells with respect to PA cells , AOO cells: Number of 1 km cells which intersect with the species AOO (as defined in the article) and with the site polygon, Perc. AOO: Percentage of AOO cells with respect to PA cells .

Asplenium majoricum

Table C.1: *Asplenium majoricum* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000212	SIERRA DE MARTÉS-MUELA DE CORTES	1554	1113	71.6
ES0000468	SERRÀ D'ESPADÀ	751	609	81.1
ES0000453	MUNTANYES DE LA MARINA	557	556	99.8
ES5140011	SISTEMA PRELITORAL MERIDIONAL	680	463	68.1
ES5233040	MUELA DE CORTES Y EL CAROCHE	690	442	64.1
ES5222001	SERRA D'ESPADÀ	364	343	94.2
ES5233011	SIERRAS DE MARTÉS Y EL AVE	423	333	78.7
ES5140009	TIVISSA-VANDELLÒS-LLABERIA	321	321	100.0
ES0000449	ALTO TURIA Y SIERRA DEL NEGRETE	1126	316	28.1
ES5110013	SERRES DEL LITORAL CENTRAL	375	312	83.2
ES0000474	SERRES DE MARIOLA I EL CARRASCAL DE LA FONT ROJA	278	269	96.8
ES0000458	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	260	260	100.0
ES0000023	L'ALBUFERA	255	255	100.0
ES0000471	L'ALBUFERA	255	255	100.0
ES0000469	SERRA CALDERONA	253	251	99.2
ES5232002	SERRA CALDERONA	240	240	100.0
ES5213019	AITANA, SERRELLA I PUIGCAMPANA	239	238	99.6
ES0000213	SERRES DE MARIOLA I EL CARRASCAR DE LA FONT ROJA	246	237	96.3
ES5140006	SERRES DE CARDÓ- EL BOIX	217	217	100.0
ES5213042	VALLS DE LA MARINA	212	212	100.0
ES5212008	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	191	191	100.0
ES5223055	SERRA D'EN GALCERÀN	169	168	99.4
ES0000465	L'ALT MAESTRAT, TINENÇA DE BENIFASSÀ, TURMELL I VALLIVANA	1107	159	14.4
ES5140017	SERRA DE MONTSANT-PAS DE L'ASE	262	155	59.2
ES0000020	DELTA DE L'EBRE	223	153	68.6
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	149	100.0
ES0000261	SIERRA DE ALMENARA, MORERAS Y CABO COPE	327	141	43.1
ES5310027	CIMALS DE LA SERRA	135	135	100.0
ES5110011	SERRES DEL LITORAL SEPTENTRIONAL	308	132	42.9
ES5213054	ELS ALFORINS	128	128	100.0
ES6200035	SIERRA DE LA ALMENARA	273	127	46.5
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	122	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5233001	TINENÇA DE BENIFASSÀ, TURMELL I VALLIVANA	571	121	21.2
ES0000466	PENYAGOLOSA	612	120	19.6
ES5120007	CAP DE CREUS	155	117	75.5
ES5120014	L'ALBERA	225	117	52.0
ES0000073	COSTA BRAVA DE MALLORCA	143	116	81.1
ES0000457	SIERRA DE SALINAS	117	115	98.3
ES0000227	MUNTANYES D'ARTÀ	129	113	87.6
ES5213039	SIERRA DE SALINAS	115	113	98.3
ES0000441	D'ALFABIA A BINIARROI	112	112	100.0
ES5110024	SERRA DE COLLSEROLA	114	107	93.9
ES5233044	SIERRA DE MALACARA	185	107	57.8
ES0000298	MATARRAÑA - AIGUABARREIX	434	101	23.3
ES0000444	SERRA D'IRTA	105	94	89.5
ES5223036	SERRA D'IRTA	105	94	89.5
ES5233045	SERRA D'ENGUERA	211	94	44.5
ES0000455	ELS ALFORINS	92	92	100.0
ES5232003	CURS MITJÀ DEL RIU PALÀNCIA	93	88	94.6
ES5140018	EL MONTMELL-MARMELLAR	142	85	59.9
ES5233013	SERRA DE CORBERA	83	83	100.0
ES5140005	SERRA DE MONTSIÀ	83	82	98.8
ES5140012	TOSSALS D'ALMATRET I RIBA ROJA	108	82	75.9
ES0000264	SIERRA DE LA MUELA Y CABO TIÑOSO	147	80	54.4
ES5120010	LES GAVARRES	344	80	23.3
ES0000019	AIGUAMOLLS DE L'ALT EMPORDÀ	89	78	87.6
ES5222004	CURS ALT DEL RIU MILLARS	165	76	46.1
ES0000463	CABEÇO D'OR I LA GRANA	74	74	100.0
ES0000464	SIERRA ESCALONA Y DEHESA DE CAMPOAMOR	136	73	53.7
ES0000230	LA VALL	74	72	97.3
ES5140015	RIU SIURANA I PLANES DEL PRIORAT	72	72	100.0
ES6200015	LA MUELA Y CABO TIÑOSO	110	70	63.6
ES5310029	NA BORGES	69	69	100.0
ES5140019	RIU GAIÀ	67	67	100.0
ES5140008	MUNTANYES DE PRADES	379	65	17.2
ES0000081	CAP ENDERROCAT-CAP BLANC	80	64	80.0
ES5213020	SERRES DEL FERRER I BÈRNIA	57	57	100.0
ES0000460	RIU MONTNEGRE	56	56	100.0
ES2420118	RÍO ALGARS	65	56	86.2
ES5120016	EL MONTGRÍ- LES MEDES - EL BAIX TER	77	56	72.7
ES6110008	SIERRAS DE GADOR Y ENIX	598	55	9.2
ES5212012	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	54	70.1
ES5232007	RIU XÚQUER	74	54	73.0
ES5310092	MUNTANYES DE POLLENÇA	54	54	100.0
ES5120013	MASSÍS DE LES CADIRETES	122	52	42.6

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000228	CAP DE SES SALINES	60	51	85.0
ES5140003	RIBERA DE L'ALGARS	51	50	98.0
ES0000231	DELS ALOCS A FORNELLS	52	49	94.2
ES5233041	SERRA DE LA SAFOR	49	49	100.0
ES0000446	DESERT DE LES PALMES	48	48	100.0
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	47	61.8
ES5221002	DESERT DE LES PALMES	47	47	100.0
ES5233009	SIERRA DEL NEGRETE	285	47	16.5
ES0000461	SERRES DEL SUD D'ALACANT	142	46	32.4
ES5140023	SECANS DEL MONTSIÀ	46	46	100.0
ES5310032	CAP LLENTRISCA-SA TALAIA	50	46	92.0
ES0000059	LLACUNES DE LA MATA I TORREVIEJA.	60	45	75.0
ES5140014	MASSÍS DE BONASTRE	45	45	100.0
ES5213022	SERRA DE CREVILLENT	78	45	57.7
ES0000173	SIERRA ESPUÑA	223	44	19.7
ES5310113	LA VALL	46	44	95.7
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES0000237	DES CANUTELLS A LLUCALARI	45	42	93.3
ES0000120	SALINAS DE SANTA POLA.	44	41	93.2
ES0000239	DE BINIGAUS A CALA MITJANA	48	41	85.4
ES0000445	PLANIOLS-BENASQUES	38	38	100.0
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	37	92.5
ES5211007	MONTGÓ	40	37	92.5
ES0000038	S'ALBUFERA DE MALLORCA	39	36	92.3
ES5310008	ES GALATZÓ-S'ESCLOP	36	36	100.0
ES0000443	SUD DE CIUTADELLA	38	35	92.1
ES6200001	CALBLANQUE, MONTE DE LAS CENIZAS Y PEÑA DEL ÁGUILA	52	35	67.3
ES6200009	SIERRA DE EL CARCHE	86	35	40.7
ES0000442	DE LA SERRA DE L'ESPERÓ AL PENYAL ALT	34	34	100.0
ES5140002	SERRA DE GODALL	34	34	100.0
ES5310079	PUIG DE NA BAUÇÀ	34	34	100.0
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES0000440	DES TEIX AL PUIG DE SES FITES	32	32	100.0
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	32	100.0
ES5140010	RIBERES I ILLES DE L'EBRE	32	32	100.0
ES5223007	MARJAL D'ALMENARA	32	32	100.0
ES0000235	DE S'ALBUFERA A LA MOLA	41	31	75.6
ES0000386	CAPELL DE FERRO	30	30	100.0
ES0000238	SON BOU I BARRANC DE SA VALL	29	28	96.6
ES0000260	MAR MENOR	67	28	41.8
ES5140016	TOSSAL DE MONTAGUT	28	28	100.0
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	28	82.4

Code	Name	PA cells	PSA cells	Perc. PSA
ES2430097	RÍO MATARRANYA	106	27	25.5
ES5212004	RIU GORGOS	27	27	100.0
ES5232008	CURS MITJÀ DEL RIU ALBAIDA	27	27	100.0
ES0000234	S'ALBUFERA DES GRAU	31	26	83.9
ES5120015	LITORAL DEL BAIX EMPORDÀ	51	26	51.0
ES5223002	L'ALT MAESTRAT	525	25	4.8
ES5310034	SERRA GROSSA	25	25	100.0
ES5310112	NORD DE SANT JOAN	26	25	96.2
ES0000147	MARJAL DE PEGO-OLIVA.	24	24	100.0
ES0000385	BARBATX	24	24	100.0
ES5233030	MARJAL DE LA SAFOR	24	24	100.0
ES0000045	SIERRA ALHAMILLA	111	23	20.7
ES5213018	PENYA-SEGATS DE LA MARINA	31	23	74.2
ES5310101	RANDA	23	23	100.0
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	22	84.6
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	22	75.9
ES0000233	D'ADDAIA A S'ALBUFERA	35	22	62.9
ES0000439	PLA DE SA MOLA	22	22	100.0
ES5110025	RIU CONGOST	37	22	59.5
ES6200008	SIERRA SALINAS	24	21	87.5
ES0000174	SIERRA DE LA PILA	109	20	18.3
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES0000381	PUIG GROS	20	20	100.0
ES0000456	MORATILLAS-ALMELA	48	20	41.7
ES5120011	RIBERES DEL BAIX TER	80	20	25.0
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	20	40.0
ES6110005	SIERRA DE CABRERA-BEDAR	413	20	4.8
ES6200003	SIERRA DE LA PILA	119	20	16.8
ES5222005	MARJAL DE NULES	19	19	100.0
ES6200006	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	19	47.5
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES5310009	ES TEIX	18	18	100.0
ES5310102	XORRIGO	18	18	100.0
ES5310024	LA MOLA	27	17	63.0
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	17	73.9
ES0000146	DELTA DEL LLOBREGAT	28	16	57.1
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5310033	XARRACA	19	16	84.2
ES6200002	CARRASCOY Y EL VALLE	168	16	9.5
ES6200030	MAR MENOR	45	16	35.6
ES0000148	MARJAL DELS MOROS.	15	15	100.0
ES0000470	MARJAL DELS MOROS	15	15	100.0
ES5120021	RIU FLUVIÀ	113	15	13.3

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310010	COMUNA DE BUNYOLA	15	15	100.0
ES5310083	ES BOIXOS	15	15	100.0
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000145	MONDRAGÓ	15	14	93.3
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000240	COSTA SUD DE CIUTADELLA	25	14	56.0
ES5213024	TABARCA	24	14	58.3
ES5213025	DUNES DE GUARDAMAR	19	14	73.7
ES5232006	ALTO TÚRIA	262	14	5.3
ES5310080	PUIGPUNYENT	14	14	100.0
ES6200029	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	13	18.6
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	12	66.7
ES0000175	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	12	70.6
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES0000462	CLOT DE GALVANY	12	12	100.0
ES0000467	PRAT DE CABANES I TORREBLANCA	18	12	66.7
ES5211009	IFAC	14	12	85.7
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310090	PUIG D'ALARÒ-PUIG DE S'ALCADENA	12	12	100.0
ES5310098	CALES DE MANACOR	16	12	75.0
ES0000079	LA VICTÒRIA	16	11	68.8
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	11	73.3
ES0000225	SA COSTERA	14	11	78.6
ES5310089	BINIARROI	11	11	100.0
ES5310091	MOSSA	11	11	100.0
ES5310104	COSTA DE L'OEST D'EIVISSA	26	11	42.3
ES0000199	SIERRA DE LA FAUSILLA	20	10	50.0
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6
ES5310081	PORT DES CANONGE	14	10	71.4
ES5310085	MONCAIRE	10	10	100.0
ES5310087	BÀLITX	12	10	83.3
ES6200025	SIERRA DE LA FAUSILLA	21	10	47.6
ES6200037	SIERRA DEL SERRAL	28	10	35.7
ES0000226	L'ALBUFERETA	10	9	90.0
ES5140001	LITORAL MERIDIONAL TARRAGONÍ	20	9	45.0
ES5140022	BARRANC DE SANTES CREUS	9	9	100.0
ES5310026	FITA DES RAM	9	9	100.0
ES5310068	CAP NEGRE	9	9	100.0
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	9	69.2
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES6200024	CABEZO DE ROLDÁN	22	9	40.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000379	PUIG DE SES FITES	8	8	100.0
ES5223004	PENYAGOLOSA	384	8	2.1
ES0000058	EL FONDO D'ELX-CREVILLENT	39	7	17.9
ES0000378	PUIG DES BOIXOS	7	7	100.0
ES5212006	LAGUNA DE SALINAS	8	7	87.5
ES5212009	ALGEPSARS DE FINESTRAT	7	7	100.0
ES5213033	CABO ROIG	11	7	63.6
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES6200011	SIERRA DE LAS MORERAS	50	7	14.0
ES0000221	SA DRAGONERA	15	6	40.0
ES0000222	LA TRAPA	10	6	60.0
ES0000383	PUIG DES CASTELL	6	6	100.0
ES5110007	RIU I ESTANYS DE TORDERA	38	6	15.8
ES5140007	COSTES DEL TARRAGONÈS	14	6	42.9
ES5310015	PUIG DE SANT MARTÍ	6	6	100.0
ES5310088	GORG BLAU	6	6	100.0
ES5310093	FORMENTOR	7	6	85.7
ES0000377	MOLA DE SON PACS	5	5	100.0
ES5212007	SALERO Y CABECICOS DE VILLENA	17	5	29.4
ES5213032	CAP DE LES HORTES	15	5	33.3
ES5222002	MARJAL DE PENÍSCOLA	5	5	100.0
ES5233012	VALLE DE AYORA Y SIERRA DEL BOQUERÓN	219	5	2.3
ES5310076	SERRAL D'EN SALAT	6	5	83.3
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000223	SA FORADADA	5	4	80.0
ES0000380	PUIG DE S'EXTREMERA	4	4	100.0
ES0000382	ALARÓ	4	4	100.0
ES0000384	BARRANC DE SANTA ANNA	4	4	100.0
ES5120005	RIU LLOBREGAT D'EMPORDÀ	28	4	14.3
ES5233047	ULLALS DEL RIU VERD	4	4	100.0
ES5310028	ES BINIS	4	4	100.0
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES5310118	TORRE LLAFUDA	4	4	100.0
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000224	MULETA	7	3	42.9
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5310031	PORROIG	3	3	100.0
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	3	100.0
ES5310099	PORTOCOLOM	5	3	60.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES5310119	PENYES D'EGIPTE	3	3	100.0
ES5310120	ES CLOT DES GUIX	3	3	100.0
ES5310122	MAL LLOC	3	3	100.0
ES6200012	CALNEGRE	18	3	16.7
ES6200048	MEDIO MARINO	15	3	20.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000214	ILLOTS DE TABARCA	12	2	16.7
ES5110020	COSTES DEL GARRAF	12	2	16.7
ES5140004	SÈQUIA MAJOR	4	2	50.0
ES5223005	ALT PALÀNCIA	314	2	0.6
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310084	TORRE PICADA	5	2	40.0
ES5310086	MONNÀBER	2	2	100.0
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES5310114	BINIGAFULL	2	2	100.0
ES5310115	ES MOLINET	2	2	100.0
ES5310121	BINIGURDÓ	2	2	100.0
ES6110006	RAMBLAS DE GERGAL, TABERNAS Y SUR DE SIERRA ALHAMILLA	324	2	0.6
ES6200023	SIERRA DE LA TERCIA	73	2	2.7
ES0000307	PUERTOS DE BECEITE	189	1	0.5
ES0000447	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES2420119	ELS PORTS DE BESEIT	138	1	0.7
ES5110015	SISTEMA PRELITORAL CENTRAL	293	1	0.3
ES5140020	GRAPISSAR DE LA MASIA BLANCA	4	1	25.0
ES5212010	ARENAL DE PETRER	1	1	100.0
ES5214002	TUNEL DE CANALS	1	1	100.0
ES5214004	COVA JOLIANA	1	1	100.0
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5223037	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5224001	COVA OSCURA-ATZENETA DEL MAESTRAT	1	1	100.0
ES5232009	SERRA DEL CASTELL DE XÀTIVA	1	1	100.0
ES5233049	COVA DE LES RATES PENADES (RÒTOVA)	1	1	100.0
ES5233051	COVA DE LES MERAVELLES DE LLOMBAI	1	1	100.0
ES5234001	COVA DEL SARDINER-SAGUNT	1	1	100.0
ES5234005	SIMA DE L'ÀGUILA-PICASSENT	1	1	100.0
ES5310040	COVA DE LES MARAVELLES	1	1	100.0
ES5310042	AVENC D'EN CORBERA	1	1	100.0
ES5310048	COVA DE SA GUITARRETA	1	1	100.0
ES5310050	COVA D'EN BESSÓ	1	1	100.0
ES5310055	COVA DES PIRATA	1	1	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310058	COVA DE CAN SION	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310060	COVA MORELLA	1	1	100.0
ES5310061	COVA NOVA DE SON LLUÍS	1	1	100.0
ES5310062	ES BUFADOR DE SON BERENGUER	1	1	100.0
ES5310063	COVA DE CAN MILLO O DE COA NEGRINA	1	1	100.0
ES5310064	AVENC DE SON POU	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310116	BINIATRUM	1	1	100.0
ES5310117	SES PALLISSES	1	1	100.0
ES5310123	BASSA DE FORMENTERA	1	1	100.0
ES6200027	SIERRA DE ABANILLA	23	1	4.3
	SPAIN TOTAL:	28261	15904	56.3
FRANCE				
FR9310019	CAMARGUE	899	697	77.5
FR9301592	CAMARGUE	884	686	77.6
FR9301622	LA PLAINE ET LE MASSIF DES MAURES	450	414	92.0
FR9301595	CRAU CENTRALE - CRAU SECHE	525	376	71.6
FR9310064	CRAU	493	362	73.4
FR9101406	PETITE CAMARGUE	405	310	76.5
FR9112013	PETITE CAMARGUE LAGUNO-MARINE	208	186	89.4
FR9400577	RIVIERE ET VALLEE DU FANGO	249	142	57.0
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	135	66.8
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	133	73.5
FR9310069	GARRIGUES DE LANÇON ET CHAÎNES ALENTOUR	348	132	37.9
FR9301608	MONT CAUME - MONT FARON - FORET DOMANIALE DES MORIERES	171	130	76.0
FR9301603	CHAINE DE L'ETOILE- MASSIF DU GARLABAN	139	127	91.4
FR9112007	ETANGS DU NARBONNAIS	142	122	85.9
FR9400570	AGRIATES	151	119	78.8
FR9110080	MONTAGNE DE LA CLAPE	120	106	88.3
FR9301628	ESTEREL	124	106	85.5
FR9101453	MASSIF DE LA CLAPE	113	105	92.9
FR9301596	MARAIS DE LA VALLEE DES BAUX ET MARAIS D'ARLES	189	104	55.0
FR9112018	ETANG DE THAU ET LIDO DE SETE A AGDE	110	98	89.1
FR9312001	MARAIS ENTRE CRAU ET GRAND RHÔNE	110	94	85.5

Code	Name	PA cells	PSA cells	Perc. PSA
FR9101440	COMPLEXE LAGUNAIRE DE BAGES-SIGEAN	106	93	87.7
FR9101408	ETANG DE MAUGUIO	102	90	88.2
FR9112017	ETANG DE MAUGUIO	102	90	88.2
FR9112022	EST ET SUD DE BEZIERS	94	84	89.4
FR9312014	COLLE DU ROUET	151	84	55.6
FR9101463	COMPLEXE LAGUNAIRE DE SALSES	89	82	92.1
FR9112005	COMPLEXE LAGUNAIRE DE SALSES-LEUCATE	85	79	92.9
FR9101483	MASSIF DES ALBERES	103	75	72.8
FR9112023	MASSIF DES ALBERES	105	75	71.4
FR9101410	ETANGS PALAVASIENS	100	73	73.0
FR9110042	ETANGS PALAVASIENS ET ÉTANG DE L'ESTAGNOL	100	73	73.0
FR9301626	VAL D'ARGENS	240	72	30.0
FR9312009	PLATEAU DE L'ARBOIS	68	68	100.0
FR9301601	COTE BLEUE - CHAINE DE L'ESTAQUE	84	67	79.8
FR9310110	PLAINE DES MAURES	66	66	100.0
FR9110108	BASSE PLAINE DE L'AUDE	72	63	87.5
FR9301590	LE RHONE AVAL	318	60	18.9
FR9101411	HERBIERS DE L'ETANG DE THAU	67	59	88.1
FR9412007	VALLÉE DU REGINO	56	56	100.0
FR9112001	CAMARGUE GARDOISE FLUVIO-LACUSTRE	90	49	54.4
FR9301613	RADE D'HYERES	141	48	34.0
FR9112006	ETANG DE LAPALME	55	45	81.8
FR9101405	LE PETIT RHONE	73	44	60.3
FR9400568	CAP CORSE NORD ET ILE FINOCCHIAROLA, GIRAGLIA ET CAPENSE (COTE DE MACINAGGIO A C	47	44	93.6
FR9110111	BASSES CORBIÈRES	474	43	9.1
FR9101435	BASSE PLAINE DE L'AUDE	47	42	89.4
FR9101439	COLLINES DU NARBONNAIS	45	42	93.3
FR9310020	ILES D'HYÈRES	130	38	29.2
FR9301597	MARAIS ET ZONES HUMIDES LIEES A L'ETANG DE BERRE	37	37	100.0
FR9101436	COURS INFERIEUR DE L'AUDE	43	36	83.7
FR9112020	PLAINE DE FABREGUES-POUSSAN	51	36	70.6
FR9400602	BASSE VALLÉE DU TAVIGNANO	55	36	65.5
FR9301568	CORNICHES DE LA RIVIERA	48	35	72.9
FR9312002	PRÉALPES DE GRASSE	312	33	10.6
FR9402013	PLATEAU DU CAP CORSE	40	30	75.0
FR9410113	FORÊTS TERRITORIALES DE CORSE	276	30	10.9
FR9101465	COMPLEXE LAGUNAIRE DE CANET	31	28	90.3
FR9112025	COMPLEXE LAGUNAIRE DE CANET-SAINT NAZAIRE	31	28	90.3
FR9410098	URBINO	41	28	68.3
FR9301574	GORGES DE LA SIAGNE	92	27	29.3
FR9301625	FORET DE PALAYSON - BOIS DU ROUET	82	27	32.9

Code	Name	PA cells	PSA cells	Perc. PSA
FR9312015	ETANGS ENTRE ISTRES ET FOS	28	26	92.9
FR9412009	PLATEAU DU CAP CORSE	32	26	81.2
FR9112008	CORBIERES ORIENTALES	311	25	8.0
FR9301571	RIVIERE ET GORGES DU LOUP	84	24	28.6
FR9410097	ILES FINOCCHIAROLA ET CÔTE NORD	27	24	88.9
FR9312025	BASSE VALLÉE DU VAR	31	23	74.2
FR9400571	ETANG DE BIGUGLIA	37	23	62.2
FR9301567	VALLEE DU CARAI - COLLINES DE CASTILLON	73	22	30.1
FR9410101	ETANG DE BIGUGLIA	35	22	62.9
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	22	55.0
FR9101441	COMPLEXE LAGUNAIRE DE LAPALME	31	21	67.7
FR9112021	PLAINE DE VILLEVEYRAC-MONTAGNAC	74	20	27.0
FR9301627	EMBOUCHURE DE L'ARGENS	24	20	83.3
FR9101486	COURS INFERIEUR DE L'HERAULT	21	19	90.5
FR9301569	VALLONS OBSCURS DE NICE ET DE SAINT BLAISE	28	19	67.9
FR9101478	LE TECH	79	17	21.5
FR9101481	COTE ROCHEUSE DES ALBERES	28	17	60.7
FR9400603	RIVIERE DE LA SOLENZARA	65	17	26.2
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	16	76.2
FR9402017	GOLFE D'AJACCIO	66	16	24.2
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	16	24.2
FR9402012	CAPO DI FENO	29	15	51.7
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	14	56.0
FR9312005	SALINES DE L'ETANG DE BERRE	11	11	100.0
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	11	50.0
FR9101412	ETANG DU BAGNAS	13	10	76.9
FR9110034	ETANG DU BAGNAS	12	10	83.3
FR9301610	CAP SICIE - SIX FOURS	18	10	55.6
FR9101391	LE VIDOURLE	30	9	30.0
FR9400601	ALISO-OLETTA	9	9	100.0
FR9101493	EMBOUCHURE DU TECH ET GRAU DE LA MASSANE	14	8	57.1
FR9112034	CAP BEAR- CAP CERBERE	16	8	50.0
FR9400572	MUCCHIATANA	9	8	88.9
FR9400598	MASSIF DU TENDA ET FORET DE STELLA	52	8	15.4
FR9400600	CRETES DE TEGHIME-POGGIO D'OLETTA	8	8	100.0
FR9301609	LA POINTE FAUCONNIERE	11	7	63.6
FR9301624	CORNICHE VAROISE	34	7	20.6
FR9312016	FALAISES DU MONT CAUME	7	7	100.0
FR9312018	FALAISES DE VAUFRÈGES	7	7	100.0
FR9101442	PLATEAU DE LEUCATE	9	6	66.7
FR9301572	DOME DE BIOT	6	6	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400599	STRETTES DE ST FLORENT	6	6	100.0
FR9112030	PLATEAU DE LEUCATE	8	5	62.5
FR9301570	PREALPES DE GRASSE	244	5	2.0
FR9402007	SITE À BOTRYCHIUM SIMPLE ET CHÂTAIGNERAIES DU BOZZIO	29	5	17.2
FR9101430	PLATEAU DE ROQUEHAUTE	4	4	100.0
FR9101433	LA GRANDE MAIRE	9	4	44.4
FR9112035	COTE LANGUEDOCIENNE	44	4	9.1
FR9301605	MONTAGNE SAINTE VICTOIRE - FORET DE PEYROLLES - MONTAGNE DES UBACS - MONTAGNE D’	370	4	1.1
FR9301998	BAIE DE LA CIOTAT	10	4	40.0
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	4	36.4
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9400619	CAMPO DELL’ORO (AJACCIO)	3	3	100.0
FR9402005	CHATAÎGNERAIES ET RUISEAUX DE CASTAGNICCIA	8	3	37.5
FR9101393	MONTAGNE DE LA MOURE ET CAUSSE D’AUMELAS	137	2	1.5
FR9101431	MARE DU PLATEAU DE VENDRES	2	2	100.0
FR9101434	LES ORPELLIERES	7	2	28.6
FR9101487	GROTTE DE LA RATAPANADE	2	2	100.0
FR9101489	VALLEE DE L’ORBIEU	262	2	0.8
FR9102001	FRICHES HUMIDES DE TORREMILLA	4	2	50.0
FR9301996	CAP FERRAT	19	2	10.5
FR9301999	COTE BLEUE MARINE	30	2	6.7
FR9312007	ILES MARSEILLAISES - CASSIDAIGNE	45	2	4.4
FR9312017	FALAISES DE NIOLON	5	2	40.0
FR9400569	CRETES DU CAP CORSE, VALLON DE SISCO	2	2	100.0
FR9400613	CAVITES A CHAUVES-SOURIS DE CASTIFAO, MURACCIOLE, OLMETA DI TUDA ET COGGIA-TEMUL	3	2	66.7
FR9402006	STATIONS À CHOUX INSULAIRES DE BARBAGGIO ET POGGIO D’OLETTA	2	2	100.0
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9412008	CHÊNAIES ET PINÈDES DE CORSE	23	2	8.7
FR9101416	CARRIERES DE NOTRE-DAME DE L’AGENOUILLADE	1	1	100.0
FR9101464	CHATEAU DE SALSES	1	1	100.0
FR9102012	PROLONGEMENT EN MER DES CAP ET ETANG DE LEUCATE	4	1	25.0
FR9102014	BANCS SABLEUX DE L’ESPIGUETTE	16	1	6.2
FR9301573	BAIE ET CAP D’ANTIBES - ILES DE LERINS	18	1	5.6
FR9310067	MONTAGNE SAINTE VICTOIRE	201	1	0.5
FR9400582	PLATEAU DU COSCIONE ET MASSIF DE L’INCUDINE	151	1	0.7
FR9400583	FORET DE L’OSPEDALE	16	1	6.2
FR9400593	ROCCAPINA-ORTOLO	24	1	4.2

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400616	JUNIPERAIE DE PORTO POLLO ET PLAGE DE CUPABIA	9	1	11.1
FR9400618	MARAIS ET TOURBIERES DU VALDO ET DE BAGLIETTO	8	1	12.5
FR9402011	ANCIENNES GALERIES DE MINES DE LOZARI/BELGODERE(SITE À CHAUVES-SOURIS)	1	1	100.0
FR9410109	AIGUILLES DE BAVELLA	31	1	3.2
	FRANCE TOTAL:	13887	7610	54.8
ITALY				
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	425	55.2
IT9110039	PROMONTORIO DEL GARGANO	874	394	45.1
IT9110008	VALLONI E STEPPE PEDEGARGANICHE	362	237	65.5
IT9310304	ALTO IONIO COSENTINO	381	205	53.8
IT9110038	PALUDI PRESSO IL GOLFO DI MANFREDONIA	205	149	72.7
IT9110005	ZONE UMIDE DELLA CAPITANATA	202	146	72.3
IT9130007	AREA DELLE GRAVINE	359	102	28.4
IT9310303	POLLINO E ORSOMARSO	1104	92	8.3
IT51A0029	BOSCHI DELLE COLLINE DI CAPALBIO	87	87	100.0
IT6040015	PARCO NAZIONALE DEL CIRCEO	151	81	53.6
IT9110009	VALLONI DI MATTINATA - MONTE SACRO	97	77	79.4
IT51A0008	MONTE D'ALMA	79	76	96.2
IT5160012	MONTE CAPANNE E PROMONTORIO DELL'ENFOLA	95	72	75.8
IT6030084	CASTEL PORZIANO (TENUTA PRESIDENZIALE)	81	71	87.7
IT5160102	ELBA ORIENTALE	83	67	80.7
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	65	77.4
IT51A0036	PIANURE DEL PARCO DELLA MAREMMA	61	61	100.0
IT51A0026	LAGUNA DI ORBETELLO	58	54	93.1
IT51A0016	MONTI DELL'UCCELLINA	65	53	81.5
IT9110012	TESTA DEL GARGANO	97	53	54.6
IT9110004	FORESTA UMBRA	255	46	18.0
ITB020014	GOLFO DI OROSEI	307	42	13.7
IT9110015	DUNA E LAGO DI LESINA - FOCE DEL FORTORE	148	41	27.7
IT8050048	COSTA TRA PUNTA TRESINO E LE RIPE ROSSE	54	39	72.2
IT1324910	MONTE ACUTO - POGGIO GRANDE - RIO TORSERO	45	35	77.8
IT6010056	SELVA DEL LAMONE E MONTI DI CASTRO	109	35	32.1
IT9150002	COSTA OTRANTO - SANTA MARIA DI LEUCA	74	35	47.3
IT6040014	FORESTA DEMANIALE DEL CIRCEO	47	33	70.2
IT9120011	VALLE OFANTO - LAGO DI CAPACIOTTI	192	32	16.7
IT1315806	MONTE NERO - MONTE BIGNONE	55	30	54.5
IT8050047	COSTA TRA MARINA DI CAMEROTA E POLICASTRO BUSSENTINO	52	29	55.8
IT1315717	MONTE GRAMMONDO - TORRENTE BEVERA	45	28	62.2
IT9110037	LAGHI DI LESINA E VARANO	212	28	13.2

Code	Name	PA cells	PSA cells	Perc. PSA
IT9130004	MAR PICCOLO	39	28	71.8
IT1323201	FINALESE - CAPO NOLI	49	27	55.1
ITB020041	ENTROTERRA E ZONA COSTIERA TRA BOSA, CAPO MARARGIU E PORTO TANGONE	337	27	8.0
IT6030004	VALLE DI RIO FIUME	26	26	100.0
IT9310042	FIUMARA SARACENO	27	26	96.3
IT9310025	VALLE DEL FIUME LAO	53	25	47.2
IT51A0023	ISOLA DEL GIGLIO	34	24	70.6
IT8030010	FONDALI MARINI DI ISCHIA, PROCIDA E VIVARA	69	24	34.8
IT8050013	FIUME MINGARDO	64	24	37.5
IT9130006	PINETE DELL'ARCO IONICO	67	23	34.3
IT1315602	PIZZO D'EVIGNO	35	22	62.9
IT51A0011	PADULE DI DIACCIA BOTRONA	24	22	91.7
IT51A0021	MEDIO CORSO DEL FIUME ALBEGNA	46	22	47.8
IT9310043	FIUMARA AVENA	22	22	100.0
IT6030025	MACCHIA GRANDE DI PONTE GALERIA	21	21	100.0
IT8050022	MONTAGNE DI CASALBUONO	209	21	10.0
IT9110025	MANACORE DEL GARGANO	32	21	65.6
IT9150011	ALIMINI	36	20	55.6
IT6010016	MONTI DI CASTRO	25	19	76.0
IT6010017	SISTEMA FLUVIALE FIORA - OLPETA	57	19	33.3
IT8050007	BASSO CORSO DEL FIUME BUSSENTO	23	19	82.6
IT8050012	FIUME ALENTO	95	19	20.0
IT9120002	MURGIA DEI TRULLI	95	19	20.0
IT9210150	MONTE COCCOVELLO - MONTE CRIVO - MONTE CRIVE	47	19	40.4
IT5160006	ISOLA DI CAPRAIA	33	18	54.5
IT8030005	CORPO CENTRALE DELL'ISOLA DI ISCHIA	24	18	75.0
IT8050032	MONTE TRESINO E DINTORNI	22	18	81.8
IT9130002	MASSERIA TORRE BIANCA	18	18	100.0
IT5160007	ISOLA DI CAPRAIA - AREA TERRESTRE E MARINA	32	17	53.1
IT9210265	VALLE DEL NOCE	26	17	65.4
IT6040043	MONTI AUSONI E AURUNCI	776	16	2.1
IT1324011	MONTE RAVINET - ROCCA BARBENA	41	15	36.6
IT7228221	FOCE TRIGNO - MARINA DI PETACCIATO	27	15	55.6
IT9110016	PINETA MARZINI	18	15	83.3
IT1324909	TORRENTE ARROSCIA E CENTA	15	14	93.3
IT5160013	ISOLA DI PIANOSA	21	14	66.7
IT5160016	ISOLA DI PIANOSA - AREA TERRESTRE E MARINA	22	14	63.6
IT6010035	FIUME MIGNONE (BASSO CORSO)	14	14	100.0
IT8050026	MONTE LICOSA E DINTORNI	20	14	70.0
IT9150027	PALUDE DEL CONTE, DUNE DI PUNTA PROSCIUTTO	14	14	100.0
IT9150033	SPECCHIA DELL'ALTO	14	14	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT9220055	BOSCO PANTANO DI POLICORO E COSTA IONICA FOCE SINNI	23	14	60.9
IT1315805	BASSA VALLE ARMEA	16	13	81.2
IT6030003	BOSCHI MESOFILI DI ALLUMIERE	13	13	100.0
IT6030047	BOSCO DI FOGLINO	13	13	100.0
IT6040010	LAGO DI FONDI	19	13	68.4
IT8030018	LAGO DI PATRIA	14	13	92.9
IT8050010	FASCE LITORANEE A DESTRA E A SINISTRA DEL FIUME SELE	24	13	54.2
IT8050023	MONTE BULGHERIA	35	13	37.1
IT5160014	ISOLA DI MONTECRISTO	20	12	60.0
IT5160017	ISOLA DI MONTECRISTO E FORMICA DI MONTECRISTO - AREA TERRESTRE E MARINA	20	12	60.0
IT6030044	MACCHIA DELLA SPADELLATA E FOSSO S. ANASTASIO	12	12	100.0
IT7222217	FOCE SACCIONE - BONIFICA RAMITELLI	20	12	60.0
IT9130001	TORRE COLIMENA	31	12	38.7
IT5160008	MONTE CALVI DI CAMPIGLIA	21	11	52.4
IT5160009	PROMONTORIO DI PIOMBINO E MONTE MASSONCELLO	16	11	68.8
IT51A0005	LAGO DELL'ACCESA	20	11	55.0
IT6030053	SUGHERETA DI CASTEL DI DECIMA	11	11	100.0
IT9150015	LITORALE DI GALLIPOLI E ISOLA S. ANDREA	18	11	61.1
IT9150030	BOSCO LA LIZZA E MACCHIA DEL PAGLIARONE	11	11	100.0
IT5160003	TOMBOLO DI CECINA	19	10	52.6
IT5160004	PADULE DI BOLGHERI	10	10	100.0
IT51A0010	POGGIO DI MOSCONA	15	10	66.7
IT51A0014	PINETA GRANDUCALE DELL'UCCELLINA	13	10	76.9
IT8050036	PARCO MARINO DI S. MARIA DI CASTELLABATE	21	10	47.6
IT9140002	LITORALE BRINDISINO	18	10	55.6
IT9150009	LITORALE DI UGENTO	27	10	37.0
IT1315720	FIUME ROIA	10	9	90.0
IT1324007	MONTE CIAZZE SECCHE	9	9	100.0
IT6030028	CASTEL PORZIANO (QUERCETI IGROFILI)	9	9	100.0
IT6040017	PROMONTORIO DEL CIRCEO (QUARTO FREDDO)	14	9	64.3
IT8030011	FONDALI MARINI DI PUNTA CAMPANELLA E CAPRI	69	9	13.0
IT8050011	FASCIA INTERNA DI COSTA DEGLI INFRESCHI E DELLA MASSETA	23	9	39.1
IT9110002	VALLE FORTORE, LAGO DI OCCHITO	178	9	5.1
IT9150032	LE CESINE	19	9	47.4
IT9210155	MARINA DI CASTROCUCCO	13	9	69.2
ITB023037	COSTA E ENTROTERRA DI BOSA, SUNI E MONTRESTA	126	9	7.1
IT1315716	ROVERINO	9	8	88.9
IT51A0004	POGGIO TRE CANCELLI	8	8	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT51A0012	TOMBOLO DA CASTIGLION DELLA PESCAIA A MARINA DI GROSSETO	16	8	50.0
IT8030009	FOCE DI LICOLA	8	8	100.0
IT8050039	PINETA DI SANT'ICONIO	10	8	80.0
IT9110001	ISOLA E LAGO DI VARANO	104	8	7.7
IT9150006	RAUCCIO	12	8	66.7
IT9310044	FOCE DEL FIUME CRATI	10	8	80.0
IT9310067	FORESTE ROSSANESI	60	8	13.3
ITA030044	ARCIPELAGO DELLE EOLIE - AREA MARINA E TERRESTRE	197	8	4.1
IT51A0013	PADULE DELLA TRAPPOLA, BOCCA D'OMBRONE	11	7	63.6
IT51A0030	LAGO ACQUATO, LAGO SAN FLORIANO	7	7	100.0
IT6010027	LITORALE TRA TARQUINIA E MONTALTO DI CASTRO	11	7	63.6
IT6010028	NECROPOLI DI TARQUINIA	7	7	100.0
IT6010039	ACROPOLI DI TARQUINIA	7	7	100.0
IT9140001	BOSCO TRAMAZZONE	9	7	77.8
IT9150007	TORRE ULUZZO	12	7	58.3
IT9150008	MONTAGNA SPACCATA E RUPI DI SAN MAURO	9	7	77.8
ITB020015	AREA DEL MONTE FERRU DI TERTENIA	41	7	17.1
IT1315714	MONTE ABELLIO	18	6	33.3
IT1315922	POMPEIANA	6	6	100.0
IT1323112	MONTE CARMO - MONTE SETTEPANI	110	6	5.5
IT51A0033	LAGO DI BURANO	12	6	50.0
IT8010021	PINETA DI PATRIA	11	6	54.5
IT8030015	LAGO DEL FUSARO	6	6	100.0
IT9120006	LAGHI DI CONVERSANO	20	6	30.0
IT9210160	ISOLA DI S. IANNI E COSTA PROSPICIENTE	9	6	66.7
IT1323203	ROCCA DEI CORVI - MAO - MORTOU	30	5	16.7
IT1324896	LERRONE - VALLONI	5	5	100.0
IT51A0006	PADULE DI SCARLINO	5	5	100.0
IT51A0009	MONTE LEONI	74	5	6.8
IT51A0028	DUNA DI FENIGLIA	13	5	38.5
IT6010018	LITORALE A NORD OVEST DELLE FOCI DEL FIORA	12	5	41.7
IT6030021	SUGHERETA DEL SASSO	5	5	100.0
IT6030023	MACCHIA GRANDE DI FOCENE E MACCHIA DELLO STAGNETO	7	5	71.4
IT6030027	CASTEL PORZIANO (FASCIA COSTIERA)	14	5	35.7
IT6040012	LAGHI FOGLIANO, MONACI, CAPROLACE E PANTANI DELL'INFERNO	34	5	14.7
IT6040013	LAGO DI SABAUDIA	16	5	31.2
IT6040024	RIO S. CROCE	5	5	100.0
IT8030006	COSTIERA AMALFITANA TRA NERANO E POSITANO	26	5	19.2

Code	Name	PA cells	PSA cells	Perc. PSA
IT8030038	CORPO CENTRALE E RUPI COSTIERE OCCIDENTALI DELL'ISOLA DI CAPRI	13	5	38.5
IT9140005	TORRE GUACETO E MACCHIA S. GIOVANNI	11	5	45.5
IT9150014	LE CESINE	14	5	35.7
IT9150031	MASSERIA ZANZARA	5	5	100.0
IT9210015	ACQUAFREDDA DI MARATEA	11	5	45.5
IT9310023	VALLE DEL FIUME ARGENTINO	68	5	7.4
IT9310052	CASONI DI SIBARI	9	5	55.6
IT1315719	TORRENTE NERVIA	5	4	80.0
IT5160010	PADULE ORTI - BOTTAGONE	4	4	100.0
IT6030006	MONTE TOSTO	4	4	100.0
IT6030026	LAGO DI TRAIANO	4	4	100.0
IT6040016	PROMONTORIO DEL CIRCEO (QUARTO CALDO)	12	4	33.3
IT6040018	DUNE DEL CIRCEO	33	4	12.1
IT8010020	PINETA DI CASTELVOLTURNO	4	4	100.0
IT8010027	FIUMI VOLTURNO E CALORE BENEVENTANO	219	4	1.8
IT8010028	FOCE VOLTURNO - VARICONI	8	4	50.0
IT8050038	PARETI ROCCIOSE DI CALA DEL CEFALO	6	4	66.7
IT9140006	BOSCO DI SANTA TERESA	4	4	100.0
IT9140009	FOCE CANALE GIANCOLA	5	4	80.0
IT9150021	BOSCO LE CHIUSE	4	4	100.0
IT9150029	BOSCO DI CERVALORA	4	4	100.0
IT9220080	COSTA IONICA FOCE AGRI	17	4	23.5
IT9220085	COSTA IONICA FOCE BASENTO	13	4	30.8
IT9220090	COSTA IONICA FOCE BRADANO	14	4	28.6
IT9350300	COSTA VIOLA	239	4	1.7
ITA030010	FIUME FIUMEDINISI, MONTE SCUDERI	89	4	4.5
ITA030029	ISOLA DI SALINA (STAGNO DI LINGUA)	20	4	20.0
ITA030043	MONTI NEBRODI	819	4	0.5
IT51A0015	DUNE COSTIERE DEL PARCO DELL'UCCELLINA	10	3	30.0
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0031	LAGO DI BURANO	7	3	42.9
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6010019	PIAN DEI CANGANI	4	3	75.0
IT6010026	SALINE DI TARQUINIA	6	3	50.0
IT6030016	ANTICA LAVINIUM - PRATICA DI MARE	3	3	100.0
IT6030019	MACCHIATONDA	6	3	50.0
IT6030045	LIDO DEI GIGLI	6	3	50.0
IT7222216	FOCE BIFERNO - LITORALE DI CAMPOMARINO	19	3	15.8
IT7228230	LAGO DI GUARDIALFIERA - FOCE FIUME BIFERNO	401	3	0.7
IT8010019	PINETA DELLA FOCE DEL GARIGLIANO	7	3	42.9
IT8030019	MONTE BARBARO E CRATERE DI CAMPIGLIONE	10	3	30.0
IT8030026	RUPI COSTIERE DELL'ISOLA DI ISCHIA	22	3	13.6

Code	Name	PA cells	PSA cells	Perc. PSA
IT8050024	MONTE CERVATI, CENTAURINO E MONTAGNE DI LAURINO	330	3	0.9
IT8050040	RUPI COSTIERE DELLA COSTA DEGLI INFRESCHI E DELLA MASSETA	15	3	20.0
IT9140003	STAGNI E SALINE DI PUNTA DELLA CONTESSA	10	3	30.0
IT9140007	BOSCO CURTIPETRIZZI	3	3	100.0
IT9140008	TORRE GUACETO	8	3	37.5
IT9150013	PALUDE DEL CAPITANO	4	3	75.0
IT9150018	BOSCO SERRA DEI CIANCI	5	3	60.0
IT9150024	TORRE INSERRAGLIO	5	3	60.0
IT9150025	TORRE VENERI	12	3	25.0
IT1325624	CAPO MELE	7	2	28.6
IT5160002	ISOLA DI GORGONA	6	2	33.3
IT5160005	BOSCHI DI BOLGHERI, BIBBONA E CASTIGLIONCELLO	54	2	3.7
IT5160015	ISOLA DI GORGONA - AREA TERRESTRE E MARINA	7	2	28.6
IT51A0007	PUNTA ALA E ISOLOTTO DELLO SPARVIERO	11	2	18.2
IT51A0032	DUNA DEL LAGO DI BURANO	7	2	28.6
IT6010040	MONTEROZZI	2	2	100.0
IT6030001	FIUME MIGNONE (MEDIO CORSO)	25	2	8.0
IT6030020	TORRE FLAVIA	3	2	66.7
IT6030046	TOR CALDARA (ZONA SOLFATARE E FOSSI)	2	2	100.0
IT6030048	LITORALE DI TORRE ASTURA	15	2	13.3
IT6030049	ZONE UMIDE A OVEST DEL FIUME ASTURA	3	2	66.7
IT6040007	MONTE LEANO	12	2	16.7
IT6040011	LAGO LUNGO	4	2	50.0
IT6040022	COSTA ROCCIOSA TRA SPERLONGA E GAETA	19	2	10.5
IT6040025	FIUME GARIGLIANO (TRATTO TERMINALE)	4	2	50.0
IT7140109	MARINA DI VASTO	4	2	50.0
IT8010018	VARICONI	6	2	33.3
IT8010029	FIUME GARIGLIANO	46	2	4.3
IT8030013	ISOLOTTO DI S. MARTINO E DINTORNI	2	2	100.0
IT8030014	LAGO D'AVERNO	4	2	50.0
IT8030020	MONTE NUOVO	4	2	50.0
IT8030022	PINETE DELL'ISOLA DI ISCHIA	3	2	66.7
IT8030024	PUNTA CAMPANELLA	10	2	20.0
IT8030034	STAZIONE DI CYPERUS POLYSTACHYUS DI ISCHIA	2	2	100.0
IT8050037	PARCO MARINO DI PUNTA DEGLI INFRESCHI	24	2	8.3
IT8050041	SCOGLIO DEL MINGARDO E SPIAGGIA DI CALA DEL CEFALO	5	2	40.0
IT9110030	BOSCO QUARTO - MONTE SPIGNO	105	2	1.9
IT9140004	BOSCO I LUCCI	2	2	100.0
IT9150001	BOSCO GUARINI	2	2	100.0
IT9150003	AQUATINA DI FRIGOLE	7	2	28.6

Code	Name	PA cells	PSA cells	Perc. PSA
IT9150028	PORTO CESAREO	11	2	18.2
IT9210275	MASSICCIO DEL MONTE POLLINO E MONTE ALPI	1021	2	0.2
ITA020018	FOCE DEL FIUME POLLINA E MONTE TARDARA	41	2	4.9
ITA030011	DORSALE CURCURACI, ANTENNAMARE	153	2	1.3
ITA030012	LAGUNA DI OLIVERI - TINDARI	9	2	22.2
ITA030018	PIZZO MICHELE	36	2	5.6
ITA030024	ISOLA DI FILICUDI	15	2	13.3
ITA030026	ISOLE DI STROMBOLI E STROMBOLICCHIO	19	2	10.5
ITA030042	MONTI PELORITANI, DORSALE CURCURACI, ANTENNAMARE E AREA MARINA DELLO STRETTO DI	245	2	0.8
IT1315715	CASTEL D’APPIO	1	1	100.0
IT1316001	CAPO BERTA	4	1	25.0
IT1316118	CAPO MORTOLA	3	1	33.3
IT1323202	ISOLA BERGEGGI - PUNTA PREDANI	1	1	100.0
IT1323271	FONDALI NOLI - BERGEGGI	1	1	100.0
IT1323920	MONTE GALERO	49	1	2.0
IT1324172	FONDALI FINALE LIGURE	2	1	50.0
IT6030022	BOSCO DI PALO LAZIALE	5	1	20.0
IT6030024	ISOLA SACRA	3	1	33.3
IT6040006	MONTI AUSONI MERIDIONALI	73	1	1.4
IT6040008	CANALI IN DISUSO DELLA BONIFICA PONTINA	12	1	8.3
IT6040009	MONTE S. ANGELO	4	1	25.0
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
IT6040023	PROMONTORIO GIANOLA E MONTE DI SCAURI	7	1	14.3
IT8010015	MONTE MASSICO	56	1	1.8
IT8030017	LAGO DI MISENO	4	1	25.0
IT8030032	STAZIONI DI CYANIDIUM CALDARIUM DI POZZUOLI	1	1	100.0
IT8050016	GROTTA DI MORIGERATI	1	1	100.0
IT9130003	DUNA DI CAMPOMARINO	17	1	5.9
IT9150004	TORRE DELL’ORSO	4	1	25.0
IT9150005	BOSCHETTO DI TRICASE	1	1	100.0
IT9150010	BOSCO MACCHIA DI PONENTE	1	1	100.0
IT9150012	BOSCO DI CARDIGLIANO	3	1	33.3
IT9150016	BOSCO DI OTRANTO	1	1	100.0
IT9150017	BOSCO CHIUSO DI PRESICCE	1	1	100.0
IT9150022	PALUDE DEI TAMARI	1	1	100.0
IT9150023	BOSCO DANIELI	3	1	33.3
IT9220095	COSTA IONICA FOCE CAVONE	14	1	7.1
IT9310038	SCOGLIERA DEI RIZZI	1	1	100.0
IT9350158	COSTA VIOLA E MONTE S. ELIA	22	1	4.5
IT9350179	ALICA	5	1	20.0
ITA030033	CAPO CALAVÀ	6	1	16.7

Code	Name	PA cells	PSA cells	Perc. PSA
ITB010001	ISOLA ASINARA	86	1	1.2
ITB010082	ISOLA DELL'ASINARA	91	1	1.1
ITB020012	BERCHIDA E BIDDEROSA	37	1	2.7
	ITALY TOTAL:	16585	4774	28.8
PORTUGAL				
PTZPE0004	RIA DE AVEIRO	425	39	9.2
	PORTUGAL TOTAL:	425	39	9.2
	OVERALL NATURA 2000 TOTAL:	59158	28327	47.9

Table C.2: *Asplenium majoricum* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES000045	MUNTANYES DE LA MARINA	557	500	89.8	499	89.6
ES000047	SERRES DE MARIOLA I EL CARRASCAL DE LA FONT ROJA	278	273	98.2	264	95.0
ES000002	L'ALBUFERA	255	255	100.0	255	100.0
ES000047	L'ALBUFERA	255	255	100.0	255	100.0
ES000021	SERRES DE MARIOLA I EL CARRASCAR DE LA FONT ROJA	246	244	99.2	235	95.5
ES521304	VALLS DE LA MARINA	212	212	100.0	212	100.0
ES521301	AITANA, SERRELLA I PUIGCAMPANA	239	209	87.4	208	87.0
ES000045	MONTDÚVER-MARJAL DE LA SAFOR	149	149	100.0	149	100.0
ES523301	SERRES DEL MONTDÚVER I MARXUQUERA	122	122	100.0	122	100.0
ES000044	SERRA D'IRTA	105	105	100.0	94	89.5
ES522303	SERRA D'IRTA	105	105	100.0	94	89.5
ES523301	SERRA DE CORBERA	83	83	100.0	83	100.0
ES531002	CIMALS DE LA SERRA	135	80	59.3	80	59.3
ES514000	SERRA DE MONTSIÀ	83	67	80.7	66	79.5
ES000044	D'ALFABIA A BINIARROI	112	64	57.1	64	57.1
ES000046	SERRÀ D'ESPADÀ	751	56	7.5	56	7.5
ES523304	SERRA DE LA SAFOR	49	49	100.0	49	100.0
ES000044	DESERT DE LES PALMES	48	48	100.0	48	100.0
ES522100	DESERT DE LES PALMES	47	47	100.0	47	100.0
ES523200	RIU XÚQUER	74	65	87.8	47	63.5
ES000046	CABEÇO D'OR I LA GRANA	74	45	60.8	45	60.8
ES000044	PLANIOLS-BENASQUES	38	38	100.0	38	100.0
ES000045	MONTGÓ-CAP DE SANT ANTONI	40	40	100.0	37	92.5
ES521100	MONTGÓ	40	40	100.0	37	92.5
ES531000	ES GALATZÓ-S'ESCLOP	36	36	100.0	36	100.0
ES000021	SIERRA DE MARTÉS-MUELA DE CORTES	1554	40	2.6	35	2.3
ES000045	MARJAL I ESTANYS D'ALMENARA	32	32	100.0	32	100.0
ES522300	MARJAL D'ALMENARA	32	32	100.0	32	100.0
ES521302	SERRES DEL FERRER I BÈRNIA	57	30	52.6	30	52.6
ES000044	DES TEIX AL PUIG DE SES FITES	32	28	87.5	28	87.5
ES521200	RIU GORGOS	27	27	100.0	27	100.0
ES523200	CURS MITJÀ DEL RIU ALBAIDA	27	27	100.0	27	100.0
ES000046	SERRA CALDERONA	253	25	9.9	25	9.9
ES514000	SERRA DE GODALL	34	25	73.5	25	73.5
ES523200	SERRA CALDERONA	240	25	10.4	25	10.4
ES000014	MARJAL DE PEGO-OLIVA.	24	24	100.0	24	100.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES523303	MARJAL DE LA SAFOR	24	24	100.0	24	100.0
ES000002	DELTA DE L'EBRE	223	44	19.7	21	9.4
ES000043	PLA DE SA MOLA	22	20	90.9	20	90.9
ES000044	DE LA SERRA DE L'ESPERÓ AL PENYAL ALT	34	20	58.8	20	58.8
ES522200	MARJAL DE NULES	19	19	100.0	19	100.0
ES522200	SERRA D'ESPADÀ	364	18	4.9	18	4.9
ES531000	ES TEIX	18	18	100.0	18	100.0
ES531007	DE CALA DE SES ORTIGUES A CALA ESTEL-LENCS	23	23	100.0	17	73.9
ES000014	MARJAL DELS MOROS.	15	15	100.0	15	100.0
ES000047	MARJAL DELS MOROS	15	15	100.0	15	100.0
ES531008	ES BOIXOS	15	15	100.0	15	100.0
ES000006	PRAT DE CABANES I TORREBLANCA.	18	18	100.0	12	66.7
ES000046	PRAT DE CABANES I TORREBLANCA	18	18	100.0	12	66.7
ES000021	DESEMBOCADURA DEL RIU MILLARS	15	15	100.0	11	73.3
ES000022	SA COSTERA	14	14	100.0	11	78.6
ES531008	BINIARROI	11	11	100.0	11	100.0
ES531008	PORT DES CANONGE	14	14	100.0	10	71.4
ES531008	MONCAIRE	10	10	100.0	10	100.0
ES531008	S'ESTACA-PUNTA DE DEIÀ	13	13	100.0	9	69.2
ES531009	PUIG D'ALARÒ-PUIG DE S'ALCADENA	12	9	75.0	9	75.0
ES531001	COMUNA DE BUNYOLA	15	8	53.3	8	53.3
ES531008	BÀLITX	12	9	75.0	8	66.7
ES000022	SA DRAGONERA	15	15	100.0	6	40.0
ES000022	LA TRAPA	10	10	100.0	6	60.0
ES000037	PUIG DE SES FITES	8	6	75.0	6	75.0
ES531002	FITA DES RAM	9	6	66.7	6	66.7
ES000037	MOLA DE SON PACS	5	5	100.0	5	100.0
ES522200	MARJAL DE PENÍSCOLA	5	5	100.0	5	100.0
ES531007	SERRAL D'EN SALAT	6	6	100.0	5	83.3
ES000022	SA FORADADA	5	5	100.0	4	80.0
ES000037	PUIG DES BOIXOS	7	4	57.1	4	57.1
ES000038	PUIG GROS	20	4	20.0	4	20.0
ES523304	ULLALS DEL RIU VERD	4	4	100.0	4	100.0
ES000022	MULETA	7	7	100.0	3	42.9
ES522200	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0	3	100.0
ES531002	ES BINIS	4	3	75.0	3	75.0
ES531008	GORG BLAU	6	3	50.0	3	50.0
ES000006	ILLES COLUMBRETES	4	4	100.0	2	50.0
ES514002	SECANS DEL MONTSIÀ	46	2	4.3	2	4.3
ES531007	PUIG DE NA BAUÇÀ	34	2	5.9	2	5.9
ES531008	PUIGPUNYENT	14	2	14.3	2	14.3

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES531008	TORRE PICADA	5	5	100.0	2	40.0
ES531008	MONNÀBER	2	2	100.0	2	100.0
ES000044	COSTA D'ORPESA I BENICÀSSIM	6	6	100.0	1	16.7
ES521400	TUNEL DE CANALS	1	1	100.0	1	100.0
ES521400	COVA JOLIANA	1	1	100.0	1	100.0
ES522200	PLATJA DE MONCOFA	1	1	100.0	1	100.0
ES522303	COSTA D'ORPESA I BENICÀSSIM	6	6	100.0	1	16.7
ES523200	SERRA DEL CASTELL DE XÀTIVA	1	1	100.0	1	100.0
ES523304	COVA DE LES RATES PENADES (RÒTOVA)	1	1	100.0	1	100.0
ES523400	COVA DEL SARDINER-SAGUNT	1	1	100.0	1	100.0
ES523400	SIMA DE L'ÀGUILA-PICASSENT	1	1	100.0	1	100.0
ES531004	COVA DE LES MARAVELLES	1	1	100.0	1	100.0
	SPAIN TOTAL:	7608	3995	52.5	3832	50.4
	OVERALL NATURA 2000 TOTAL:	7608	3995	52.5	3832	50.4

Table C.3: *Asplenium majoricum* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
9743	National Park	Taza	52	17	32.7
902530	UNESCO-MAB Biosphere Reserve	Taza	52	17	32.7
12350	Strict Nature Reserve	Babor	49	2	4.1
902531	UNESCO-MAB Biosphere Reserve	Gouraya	18	2	11.1
9747	National Park	Gouraya	18	2	11.1
		ALGERIA TOTAL:	189	40	21.2
		OVERALL NORTH AFRICAN TOTAL:	189	40	21.2

Carduncellus dianius

Table C.4: *Carduncellus dianius* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000023	L'ALBUFERA	255	185	72.5
ES0000471	L'ALBUFERA	255	185	72.5
ES0000020	DELTA DE L'EBRE	223	145	65.0
ES0000453	MUNTANYES DE LA MARINA	557	112	20.1
ES0000227	MUNTANYES D'ARTÀ	129	105	81.4
ES0000073	COSTA BRAVA DE MALLORCA	143	101	70.6
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	82	55.0
ES0000230	LA VALL	74	70	94.6
ES0000081	CAP ENDERROCAT-CAP BLANC	80	64	80.0
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	59	48.4
ES0000228	CAP DE SES SALINES	60	51	85.0
ES0000231	DELS ALOCS A FORNELLS	52	49	94.2
ES5213020	SERRES DEL FERRER I BÈRNIA	57	49	86.0
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	47	61.8
ES5310032	CAP LLENTRISCA-SA TALAIA	50	46	92.0
ES0000444	SERRA D'IRTA	105	44	41.9
ES5223036	SERRA D'IRTA	105	44	41.9
ES5310113	LA VALL	46	44	95.7
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES0000237	DES CANUTELLS A LLUCALARI	45	40	88.9
ES5213042	VALLS DE LA MARINA	212	40	18.9
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	37	92.5
ES5211007	MONTGÓ	40	37	92.5
ES0000038	S'ALBUFERA DE MALLORCA	39	36	92.3
ES0000443	SUD DE CIUTADELLA	38	35	92.1
ES5233013	SERRA DE CORBERA	83	34	41.0
ES0000239	DE BINIGAUS A CALA MITJANA	48	33	68.8
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	32	100.0
ES5223007	MARJAL D'ALMENARA	32	32	100.0
ES0000235	DE S'ALBUFERA A LA MOLA	41	31	75.6
ES5310029	NA BORGES	69	28	40.6
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	28	82.4
ES0000238	SON BOU I BARRANC DE SA VALL	29	27	93.1
ES5140005	SERRA DE MONTSIÀ	83	27	32.5

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000234	S'ALBUFERA DES GRAU	31	26	83.9
ES5310008	ES GALATZÓ-S'ESCLOP	36	25	69.4
ES5310034	SERRA GROSSA	25	25	100.0
ES5310112	NORD DE SANT JOAN	26	25	96.2
ES0000147	MARJAL DE PEGO-OLIVA.	24	24	100.0
ES5233030	MARJAL DE LA SAFOR	24	24	100.0
ES5213018	PENYA-SEGATS DE LA MARINA	31	23	74.2
ES5213019	AITANA, SERRELLA I PUIGCAMPANA	239	23	9.6
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	22	84.6
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	22	75.9
ES0000233	D'ADDAIA A S'ALBUFERA	35	22	62.9
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	20	40.0
ES5222005	MARJAL DE NULES	19	19	100.0
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES0000439	PLA DE SA MOLA	22	18	81.8
ES5140009	TIVISSA-VANDELLÒS-LLABERIA	321	17	5.3
ES5310024	LA MOLA	27	17	63.0
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	17	73.9
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5310033	XARRACA	19	16	84.2
ES0000148	MARJAL DELS MOROS.	15	15	100.0
ES0000470	MARJAL DELS MOROS	15	15	100.0
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000120	SALINAS DE SANTA POLA.	44	14	31.8
ES0000145	MONDRAGÓ	15	14	93.3
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000240	COSTA SUD DE CIUTADELLA	25	14	56.0
ES5232007	RIU XÚQUER	74	14	18.9
ES0000386	CAPELL DE FERRO	30	13	43.3
ES0000463	CABEÇO D'OR I LA GRANA	74	13	17.6
ES5310079	PUIG DE NA BAUÇÀ	34	13	38.2
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	12	66.7
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES0000467	PRAT DE CABANES I TORREBLANCA	18	12	66.7
ES5211009	IFAC	14	12	85.7
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310098	CALES DE MANACOR	16	12	75.0
ES0000079	LA VICTÒRIA	16	11	68.8
ES5310104	COSTA DE L'OEST D'EIVISSA	26	11	42.3
ES0000225	SA COSTERA	14	10	71.4
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310081	PORT DES CANONGE	14	10	71.4
ES0000226	L'ALBUFERETA	10	9	90.0
ES5140001	LITORAL MERIDIONAL TARRAGONÍ	20	9	45.0
ES5310068	CAP NEGRE	9	9	100.0
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	9	69.2
ES5310087	BÀLITX	12	9	75.0
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES0000446	DESERT DE LES PALMES	48	8	16.7
ES5213024	TABARCA	24	8	33.3
ES5221002	DESERT DE LES PALMES	47	8	17.0
ES0000175	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	7	41.2
ES5212009	ALGEPSARS DE FINESTRAT	7	7	100.0
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES5310083	ES BOIXOS	15	7	46.7
ES5310092	MUNTANYES DE POLLENÇA	54	7	13.0
ES0000221	SA DRAGONERA	15	6	40.0
ES0000222	LA TRAPA	10	6	60.0
ES0000260	MAR MENOR	67	6	9.0
ES0000385	BARBATX	24	6	25.0
ES0000462	CLOT DE GALVANY	12	6	50.0
ES5140022	BARRANC DE SANTES CREUS	9	6	66.7
ES5213025	DUNES DE GUARDAMAR	19	6	31.6
ES5213033	CABO ROIG	11	6	54.5
ES5310015	PUIG DE SANT MARTÍ	6	6	100.0
ES5310093	FORMENTOR	7	6	85.7
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	5	33.3
ES0000377	MOLA DE SON PACS	5	5	100.0
ES0000440	DES TEIX AL PUIG DE SES FITES	32	5	15.6
ES5213032	CAP DE LES HORTES	15	5	33.3
ES5222002	MARJAL DE PENÍSCOLA	5	5	100.0
ES5310076	SERRAL D'EN SALAT	6	5	83.3
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000223	SA FORADADA	5	4	80.0
ES0000384	BARRANC DE SANTA ANNA	4	4	100.0
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310085	MONCAIRE	10	4	40.0
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES6200030	MAR MENOR	45	4	8.9
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000224	MULETA	7	3	42.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000378	PUIG DES BOIXOS	7	3	42.9
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5310027	CIMALS DE LA SERRA	135	3	2.2
ES5310028	ES BINIS	4	3	75.0
ES5310031	PORROIG	3	3	100.0
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	3	100.0
ES5310099	PORTOCOLOM	5	3	60.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES5310120	ES CLOT DES GUIX	3	3	100.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000214	ILLOTS DE TABARCA	12	2	16.7
ES5212004	RIU GORGOS	27	2	7.4
ES5212012	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	2	2.6
ES5310009	ES TEIX	18	2	11.1
ES5310026	FITA DES RAM	9	2	22.2
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310084	TORRE PICADA	5	2	40.0
ES5310091	MOSSA	11	2	18.2
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES5310114	BINIGAFULL	2	2	100.0
ES5310115	ES MOLINET	2	2	100.0
ES5310118	TORRE LLAFUDA	4	2	50.0
ES5310119	PENYES D'EGIPTE	3	2	66.7
ES6200006	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	2	5.0
ES6200029	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	2	2.9
ES0000059	LLACUNES DE LA MATA I TORREVIEJA.	60	1	1.7
ES0000447	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5140004	SÈQUIA MAJOR	4	1	25.0
ES5140016	TOSSAL DE MONTAGUT	28	1	3.6
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5223037	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5234001	COVA DEL SARDINER-SAGUNT	1	1	100.0
ES5310048	COVA DE SA GUITARRETA	1	1	100.0
ES5310050	COVA D'EN BESSÓ	1	1	100.0
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310080	PUIGPUNYENT	14	1	7.1

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310123	BASSA DE FORMENTERA	1	1	100.0
	SPAIN TOTAL:	6463	3109	48.1
FRANCE				
FR9301592	CAMARGUE	884	104	11.8
FR9310019	CAMARGUE	899	104	11.6
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	101	50.0
FR9400570	AGRIATES	151	81	53.6
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	80	44.2
FR9101440	COMPLEXE LAGUNAIRE DE BAGES-SIGEAN	106	49	46.2
FR9112007	ETANGS DU NARBONNAIS	142	49	34.5
FR9301613	RADE D'HYERES	141	48	34.0
FR9101406	PETITE CAMARGUE	405	41	10.1
FR9310020	ILES D'HYÈRES	130	38	29.2
FR9301601	COTE BLEUE - CHAINE DE L'ESTAQUE	84	37	44.0
FR9112013	PETITE CAMARGUE LAGUNO-MARINE	208	35	16.8
FR9301622	LA PLAINE ET LE MASSIF DES MAURES	450	32	7.1
FR9402013	PLATEAU DU CAP CORSE	40	30	75.0
FR9101410	ETANGS PALAVASIENS	100	29	29.0
FR9110042	ETANGS PALAVASIENS ET ÉTANG DE L'ESTAGNOL	100	29	29.0
FR9400568	CAP CORSE NORD ET ILE FINOCCHIAROLA, GIRAGLIA ET CAPENSE (COTE DE MACINAGGIO A C	47	26	55.3
FR9412009	PLATEAU DU CAP CORSE	32	26	81.2
FR9400571	ETANG DE BIGUGLIA	37	23	62.2
FR9410097	ILES FINOCCHIAROLA ET CÔTE NORD	27	22	81.5
FR9410101	ETANG DE BIGUGLIA	35	22	62.9
FR9101463	COMPLEXE LAGUNAIRE DE SALSES	89	21	23.6
FR9112005	COMPLEXE LAGUNAIRE DE SALSES-LEUCATE	85	21	24.7
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	21	52.5
FR9301590	LE RHONE AVAL	318	18	5.7
FR9301627	EMBOUCHURE DE L'ARGENS	24	17	70.8
FR9101411	HERBIERS DE L'ETANG DE THAU	67	16	23.9
FR9112018	ETANG DE THAU ET LIDO DE SETE A AGDE	110	16	14.5
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	16	76.2
FR9101408	ETANG DE MAUGUIO	102	15	14.7
FR9112017	ETANG DE MAUGUIO	102	15	14.7
FR9312015	ETANGS ENTRE ISTRES ET FOS	28	13	46.4
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	13	52.0
FR9301610	CAP SICIE - SIX FOURS	18	10	55.6

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400572	MUCCHIATANA	9	8	88.9
FR9301624	CORNICHE VAROISE	34	7	20.6
FR9402017	GOLFE D'AJACCIO	66	7	10.6
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	7	10.6
FR9101441	COMPLEXE LAGUNAIRE DE LAPALME	31	6	19.4
FR9112006	ETANG DE LAPALME	55	6	10.9
FR9301608	MONT CAUME - MONT FARON - FORET DOMANIALE DES MORIERES	171	6	3.5
FR9301628	ESTEREL	124	6	4.8
FR9110108	BASSE PLAINE DE L'AUDE	72	5	6.9
FR9301609	LA POINTE FAUCONNIERE	11	5	45.5
FR9400577	RIVIERE ET VALLEE DU FANGO	249	5	2.0
FR9301998	BAIE DE LA CIOTAT	10	4	40.0
FR9400599	STRETTES DE ST FLORENT	6	4	66.7
FR9400601	ALISO-OLETTA	9	4	44.4
FR9101453	MASSIF DE LA CLAPE	113	3	2.7
FR9110080	MONTAGNE DE LA CLAPE	120	3	2.5
FR9112022	EST ET SUD DE BEZIERS	94	3	3.2
FR9112035	COTE LANGUEDOCIENNE	44	3	6.8
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	3	27.3
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9400619	CAMPO DELL'ORO (AJACCIO)	3	3	100.0
FR9402012	CAPO DI FENO	29	3	10.3
FR9101405	LE PETIT RHONE	73	2	2.7
FR9101412	ETANG DU BAGNAS	13	2	15.4
FR9101434	LES ORPELLIERES	7	2	28.6
FR9101436	COURS INFERIEUR DE L'AUDE	43	2	4.7
FR9110034	ETANG DU BAGNAS	12	2	16.7
FR9301996	CAP FERRAT	19	2	10.5
FR9301999	COTE BLEUE MARINE	30	2	6.7
FR9312007	ILES MARSEILLAISES - CASSIDAIGNE	45	2	4.4
FR9312017	FALAISES DE NIOLON	5	2	40.0
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	2	9.1
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9410098	URBINO	41	2	4.9
FR9412007	VALLÉE DU REGINO	56	2	3.6
FR9101416	CARRIERES DE NOTRE-DAME DE L'AGENOUILLADE	1	1	100.0
FR9101433	LA GRANDE MAIRE	9	1	11.1
FR9101435	BASSE PLAINE DE L'AUDE	47	1	2.1
FR9101442	PLATEAU DE LEUCATE	9	1	11.1
FR9101486	COURS INFERIEUR DE L'HERAULT	21	1	4.8

Code	Name	PA cells	PSA cells	Perc. PSA
FR9102014	BANCS SABLEUX DE L'ESPIGUETTE	16	1	6.2
FR9301571	RIVIERE ET GORGES DU LOUP	84	1	1.2
FR9301573	BAIE ET CAP D'ANTIBES - ILES DE LERINS	18	1	5.6
FR9301626	VAL D'ARGENS	240	1	0.4
FR9312001	MARAIS ENTRE CRAU ET GRAND RHÔNE	110	1	0.9
FR9312002	PRÉALPES DE GRASSE	312	1	0.3
	FRANCE TOTAL:	8002	1359	17.0
ITALY				
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	57	67.9
IT51A0026	LAGUNA DI ORBETELLO	58	53	91.4
IT51A0016	MONTI DELL'UCCELLINA	65	29	44.6
IT51A0036	PIANURE DEL PARCO DELLA MAREMMA	61	28	45.9
IT6030084	CASTEL PORZIANO (TENUTA PRESIDENZIALE)	81	28	34.6
IT5160102	ELBA ORIENTALE	83	27	32.5
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	26	3.4
IT6040015	PARCO NAZIONALE DEL CIRCEO	151	22	14.6
IT51A0023	ISOLA DEL GIGLIO	34	20	58.8
ITA070001	FOCE DEL FIUME SIMETO E LAGO GORNALUNGA	37	16	43.2
ITA070029	BIVIERE DI LENTINI, TRATTO MEDIANO E FOCE DEL FIUME SIMETO E AREA ANTISTANTE LA	94	15	16.0
IT5160012	MONTE CAPANNE E PROMONTORIO DELL'ENFOLA	95	13	13.7
IT51A0011	PADULE DI DIACCIA BOTRONA	24	13	54.2
IT51A0014	PINETA GRANDUCALE DELL'UCCELLINA	13	10	76.9
IT9310304	ALTO IONIO COSENTINO	381	10	2.6
IT51A0008	MONTE D'ALMA	79	9	11.4
ITA030044	ARCIPELAGO DELLE EOLIE - AREA MARINA E TERRESTRE	197	9	4.6
IT51A0012	TOMBOLO DA CASTIGLION DELLA PESCAIA A MARINA DI GROSSETO	16	8	50.0
IT6030047	BOSCO DI FOGLINO	13	8	61.5
IT51A0013	PADULE DELLA TRAPPOLA, BOCCA D'OMBRONE	11	7	63.6
IT6030044	MACCHIA DELLA SPADELLATA E FOSSO S. ANASTASIO	12	7	58.3
IT9320106	STECCATO DI CUTRO E COSTA DEL TURCHESE	16	7	43.8
IT9350172	FONDALI DA PUNTA PEZZO A CAPO DELL'ARMI	22	7	31.8
IT9320302	MARCHESATO E FIUME NETO	809	6	0.7
IT5160006	ISOLA DI CAPRAIA	33	5	15.2
IT5160007	ISOLA DI CAPRAIA - AREA TERRESTRE E MARINA	32	5	15.6
IT51A0028	DUNA DI FENIGLIA	13	5	38.5
IT51A0033	LAGO DI BURANO	12	5	41.7
IT6010018	LITORALE A NORD OVEST DELLE FOCI DEL FIORA	12	5	41.7
IT6010027	LITORALE TRA TARQUINIA E MONTALTO DI CASTRO	11	5	45.5

Code	Name	PA cells	PSA cells	Perc. PSA
IT6030023	MACCHIA GRANDE DI FOCENE E MACCHIA DELLO STAGNETO	7	5	71.4
IT6030027	CASTEL PORZIANO (FASCIA COSTIERA)	14	5	35.7
IT6040012	LAGHI FOGLIANO, MONACI, CAPROLACE E PANTANI DELL'INFERNO	34	5	14.7
IT9310042	FIUMARA SARACENO	27	5	18.5
ITA030012	LAGUNA DI OLIVERI - TINDARI	9	5	55.6
IT51A0006	PADULE DI SCARLINO	5	4	80.0
IT6030026	LAGO DI TRAIANO	4	4	100.0
IT6040017	PROMONTORIO DEL CIRCEO (QUARTO FREDDO)	14	4	28.6
IT6040018	DUNE DEL CIRCEO	33	4	12.1
IT9310044	FOCE DEL FIUME CRATI	10	4	40.0
IT9350145	FIUMARA AMENDOLEA (INCLUSO ROGHUDI, CHORIO E ROTA GRECO)	25	4	16.0
IT9350146	FIUMARA BUONAMICO	30	4	13.3
IT9350147	FIUMARA LAVERDE	19	4	21.1
IT9350160	SPIAGGIA DI BRANCALEONE	5	4	80.0
ITA030033	CAPO CALAVÀ	6	4	66.7
ITA070028	FONDALI DI ACICASTELLO (ISOLA LACHEA - CICLOPI)	7	4	57.1
IT51A0015	DUNE COSTIERE DEL PARCO DELL'UCCELLINA	10	3	30.0
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0029	BOSCHI DELLE COLLINE DI CAPALBIO	87	3	3.4
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6010019	PIAN DEI CANGANI	4	3	75.0
IT6010026	SALINE DI TARQUINIA	6	3	50.0
IT6030019	MACCHIATONDA	6	3	50.0
IT6030045	LIDO DEI GIGLI	6	3	50.0
IT6040013	LAGO DI SABAUDIA	16	3	18.8
IT9350144	CALANCHI DI PALIZZI MARINA	5	3	60.0
ITA030027	ISOLA DI VULCANO	33	3	9.1
ITA090014	SALINE DI AUGUSTA	3	3	100.0
ITA090026	FONDALI DI BRUCOLI - AGNONE	12	3	25.0
IT5160009	PROMONTORIO DI PIOMBINO E MONTE MASSONCELLO	16	2	12.5
IT5160010	PADULE ORTI - BOTTAGONE	4	2	50.0
IT51A0030	LAGO ACQUATO, LAGO SAN FLORIANO	7	2	28.6
IT51A0031	LAGO DI BURANO	7	2	28.6
IT6030004	VALLE DI RIO FIUME	26	2	7.7
IT6030020	TORRE FLAVIA	3	2	66.7
IT6030046	TOR CALDARA (ZONA SOLFATARE E FOSSI)	2	2	100.0
IT6030048	LITORALE DI TORRE ASTURA	15	2	13.3
IT6030049	ZONE UMIDE A OVEST DEL FIUME ASTURA	3	2	66.7
IT6040016	PROMONTORIO DEL CIRCEO (QUARTO CALDO)	12	2	16.7
IT6040043	MONTI AUSONI E AURUNCI	776	2	0.3

Code	Name	PA cells	PSA cells	Perc. PSA
IT8010021	PINETA DI PATRIA	11	2	18.2
IT8030010	FONDALI MARINI DI ISCHIA, PROCIDA E VIVARA	69	2	2.9
IT8030018	LAGO DI PATRIA	14	2	14.3
IT9150002	COSTA OTRANTO - SANTA MARIA DI LEUCA	74	2	2.7
IT9220080	COSTA IONICA FOCE AGRI	17	2	11.8
IT9310043	FIUMARA AVENA	22	2	9.1
IT9350132	FIUMARA DI MELITO	8	2	25.0
IT9350138	CALANCHI DI MARO SIMONE	4	2	50.0
IT9350142	CAPO SPARTIVENTO	4	2	50.0
IT9350148	FIUMARA DI PALIZZI	7	2	28.6
ITA010001	ISOLE DELLO STAGNONE DI MARSALA	19	2	10.5
ITA010026	FONDALI DELL'ISOLA DELLO STAGNONE DI MARSALA	16	2	12.5
ITA010028	STAGNONE DI MARSALA E SALINE DI TRAPANI - AREA MARINA E TERRESTRE	55	2	3.6
ITA030030	ISOLA DI LIPARI	53	2	3.8
ITA030031	ISOLA BELLA, CAPO TAORMINA E CAPO S. ANDREA	2	2	100.0
ITA030040	FONDALI DI TAORMINA - ISOLA BELLA	3	2	66.7
ITA070003	LA GURNA	4	2	50.0
ITA070004	TIMPA DI ACIREALE	13	2	15.4
IT1324909	TORRENTE ARROSCIA E CENTA	15	1	6.7
IT1325624	CAPO MELE	7	1	14.3
IT51A0007	PUNTA ALA E ISOLOTTO DELLO SPARVIERO	11	1	9.1
IT51A0032	DUNA DEL LAGO DI BURANO	7	1	14.3
IT6030016	ANTICA LAVINIUM - PRATICA DI MARE	3	1	33.3
IT6030022	BOSCO DI PALO LAZIALE	5	1	20.0
IT6030024	ISOLA SACRA	3	1	33.3
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
IT6040022	COSTA ROCCIOSA TRA SPERLONGA E GAETA	19	1	5.3
IT6040023	PROMONTORIO GIANOLA E MONTE DI SCAURI	7	1	14.3
IT6040024	RIO S. CROCE	5	1	20.0
IT8010019	PINETA DELLA FOCE DEL GARIGLIANO	7	1	14.3
IT8010020	PINETA DI CASTELVOLTURNO	4	1	25.0
IT9150009	LITORALE DI UGENTO	27	1	3.7
IT9210160	ISOLA DI S. IANNI E COSTA PROSPICIENTE	9	1	11.1
IT9310052	CASONI DI SIBARI	9	1	11.1
IT9320102	DUNE DI SOVERETO	6	1	16.7
IT9330105	FOCE DEL CROCCHIO - CROPANI	4	1	25.0
IT9350141	CAPO S. GIOVANNI	2	1	50.0
IT9350171	SPIAGGIA DI PILATI	1	1	100.0
ITA010021	SALINE DI MARSALA	14	1	7.1
ITA030028	ISOLA DI SALINA (MONTE FOSSA DELLE FELCI E DEI PORRI)	15	1	6.7

Code	Name	PA cells	PSA cells	Perc. PSA
ITA090013	SALINE DI PRIOLO	3	1	33.3
	ITALY TOTAL:	5266	654	12.4
PORTUGAL				
PTCON0018	BARRINHA DE ESMORIZ	10	3	30.0
PTZPE0004	RIA DE AVEIRO	425	2	0.5
	PORTUGAL TOTAL:	435	5	1.1
	OVERALL NATURA 2000 TOTAL:	20166	5127	25.4

Table C.5: *Carduncellus dianius* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES000045	MONTGÓ-CAP DE SANT ANTONI	40	38	95.0	35	87.5
ES521100	MONTGÓ	40	38	95.0	35	87.5
ES531010	ES AMUNTS D'EIVISSA	36	25	69.4	25	69.4
ES000024	COSTA DELS AMUNTS	21	19	90.5	19	90.5
ES521301	PENYA-SEGATS DE LA MARINA	31	23	74.2	17	54.8
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES000045	MUNTANYES DE LA MARINA	557	9	1.6	9	1.6
ES521302	SERRES DEL FERRER I BÈRNIA	57	9	15.8	9	15.8
ES521200	RIU GORGOS	27	8	29.6	2	7.4
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES531010	COSTA DE L'OEST D'EIVISSA	26	2	7.7	0	0.0
	SPAIN TOTAL:	850	186	21.9	163	19.2
	OVERALL NATURA 2000 TOTAL:	850	186	21.9	163	19.2

Table C.6: *Carduncellus dianius* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
26620	UNESCO-MAB Biosphere Reserve	El Kala	897	7	0.8
9741	National Park	El Kala	897	7	0.8
14909	Marine Park	El Kala	897	7	0.8
902531	UNESCO-MAB Biosphere Reserve	Gouraya	18	6	33.3
9747	National Park	Gouraya	18	6	33.3
72362	National Park	Tigzirt	3	3	100.0
		ALGERIA TOTAL:	2730	36	1.3
TUNISIA					
903084	Wetlands of International Importance (Ramsar)	Sebkhet Kelbia	238	20	8.4
15185	Wetland Zone of National Importance	Sebkhet Kelbia	238	20	8.4
12390	National Park	Boukornine	24	2	8.3
903087	Wetlands of International Importance (Ramsar)	Sebkhet Soliman	14	2	14.3
15194	Wetland Zone of National Importance	Sebkha Halk el Menzel	20	1	5.0
		TUNISIA TOTAL:	534	45	8.4
		OVERALL NORTH AFRICAN TOTAL:	3264	81	2.5

Diplotaxis ibicensis

Table C.7: *Diplotaxis ibicensis* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000023	L'ALBUFERA	255	124	48.6
ES0000471	L'ALBUFERA	255	124	48.6
ES0000073	COSTA BRAVA DE MALLORCA	143	76	53.1
ES0000081	CAP ENDERROCAT-CAP BLANC	80	64	80.0
ES0000227	MUNTANYES D'ARTÀ	129	61	47.3
ES0000020	DELTA DE L'EBRE	223	60	26.9
ES0000228	CAP DE SES SALINES	60	50	83.3
ES0000231	DELS ALOCS A FORNELLS	52	49	94.2
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	47	61.8
ES5310032	CAP LLENTRISCA-SA TALAIA	50	43	86.0
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES0000230	LA VALL	74	36	48.6
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES0000237	DES CANUTELLS A LLUCALARI	45	30	66.7
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	30	20.1
ES5310113	LA VALL	46	30	65.2
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	28	82.4
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	26	81.2
ES5223007	MARJAL D'ALMENARA	32	26	81.2
ES0000038	S'ALBUFERA DE MALLORCA	39	25	64.1
ES0000235	DE S'ALBUFERA A LA MOLA	41	25	61.0
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	25	62.5
ES5211007	MONTGÓ	40	25	62.5
ES5233030	MARJAL DE LA SAFOR	24	24	100.0
ES5310112	NORD DE SANT JOAN	26	24	92.3
ES0000443	SUD DE CIUTADELLA	38	23	60.5
ES5213018	PENYA-SEGATS DE LA MARINA	31	23	74.2
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	22	84.6
ES0000233	D'ADDAIA A S'ALBUFERA	35	22	62.9
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	21	72.4
ES0000239	DE BINIGAUS A CALA MITJANA	48	21	43.8
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	20	40.0
ES0000147	MARJAL DE PEGO-OLIVA.	24	19	79.2
ES0000234	S'ALBUFERA DES GRAU	31	19	61.3

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000238	SON BOU I BARRANC DE SA VALL	29	19	65.5
ES5310029	NA BORGES	69	19	27.5
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES0000453	MUNTANYES DE LA MARINA	557	17	3.1
ES5222005	MARJAL DE NULES	19	17	89.5
ES5310024	LA MOLA	27	17	63.0
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5310033	XARRACA	19	16	84.2
ES0000120	SALINAS DE SANTA POLA.	44	15	34.1
ES0000148	MARJAL DELS MOROS.	15	15	100.0
ES0000470	MARJAL DELS MOROS	15	15	100.0
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000145	MONDRAGÓ	15	14	93.3
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000240	COSTA SUD DE CIUTADELLA	25	14	56.0
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	13	56.5
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	12	66.7
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES0000467	PRAT DE CABANES I TORREBLANCA	18	12	66.7
ES5211009	IFAC	14	12	85.7
ES5213020	SERRES DEL FERRER I BÈRNIA	57	12	21.1
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310098	CALES DE MANACOR	16	12	75.0
ES0000079	LA VICTÒRIA	16	11	68.8
ES5310034	SERRA GROSSA	25	11	44.0
ES5310104	COSTA DE L’OEST D’EIVISSA	26	11	42.3
ES5310023	ILLOTS DE PONENT D’EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6
ES5310081	PORT DES CANONGE	14	10	71.4
ES0000226	L’ALBUFERETA	10	9	90.0
ES5310068	CAP NEGRE	9	9	100.0
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES5213024	TABARCA	24	8	33.3
ES5232007	RIU XÚQUER	74	8	10.8
ES5310082	S’ESTACA-PUNTA DE DEIÀ	13	8	61.5
ES0000444	SERRA D’IRTA	105	7	6.7
ES5213025	DUNES DE GUARDAMAR	19	7	36.8
ES5223036	SERRA D’IRTA	105	7	6.7
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	7	5.7
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES0000221	SA DRAGONERA	15	6	40.0
ES0000222	LA TRAPA	10	6	60.0
ES0000225	SA COSTERA	14	6	42.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000462	CLOT DE GALVANY	12	6	50.0
ES5310008	ES GALATZÓ-S'ESCLOP	36	6	16.7
ES5310015	PUIG DE SANT MARTÍ	6	6	100.0
ES5310093	FORMENTOR	7	6	85.7
ES0000386	CAPELL DE FERRO	30	5	16.7
ES5213032	CAP DE LES HORTES	15	5	33.3
ES5213042	VALLS DE LA MARINA	212	5	2.4
ES5222002	MARJAL DE PENÍSCOLA	5	5	100.0
ES5310076	SERRAL D'EN SALAT	6	5	83.3
ES5310087	BÀLITX	12	5	41.7
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000223	SA FORADADA	5	4	80.0
ES5233013	SERRA DE CORBERA	83	4	4.8
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000224	MULETA	7	3	42.9
ES0000385	BARBATX	24	3	12.5
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5310031	PORROIG	3	3	100.0
ES5310099	PORTOCOLOM	5	3	60.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	2	13.3
ES0000214	ILLOTS DE TABARCA	12	2	16.7
ES0000384	BARRANC DE SANTA ANNA	4	2	50.0
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310083	ES BOIXOS	15	2	13.3
ES5310084	TORRE PICADA	5	2	40.0
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES5310114	BINIGAFULL	2	2	100.0
ES5310115	ES MOLINET	2	2	100.0
ES0000447	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5223037	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5234001	COVA DEL SARDINER-SAGUNT	1	1	100.0
ES5310028	ES BINIS	4	1	25.0
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	1	33.3
ES5310050	COVA D'EN BESSÓ	1	1	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310120	ES CLOT DES GUIX	3	1	33.3
ES5310123	BASSA DE FORMENTERA	1	1	100.0
	SPAIN TOTAL:	4810	1987	41.3
FRANCE				
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	95	47.0
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	73	40.3
FR9301613	RADE D'HYERES	141	47	33.3
FR9400570	AGRIATES	151	39	25.8
FR9310020	ILES D'HYÈRES	130	38	29.2
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	22	55.0
FR9402017	GOLFE D'AJACCIO	66	17	25.8
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	17	25.8
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	15	71.4
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	14	56.0
FR9410098	URBINO	41	13	31.7
FR9402012	CAPO DI FENO	29	12	41.4
FR9400571	ETANG DE BIGUGLIA	37	11	29.7
FR9402013	PLATEAU DU CAP CORSE	40	11	27.5
FR9402001	CAMPOMORO-SENETOSA	40	10	25.0
FR9410101	ETANG DE BIGUGLIA	35	10	28.6
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	9	40.9
FR9400572	MUCCHIATANA	9	8	88.9
FR9412009	PLATEAU DU CAP CORSE	32	7	21.9
FR9402016	POINTE DE SENETOSA ET PROLONGEMENTS	35	5	14.3
FR9301610	CAP SICIE - SIX FOURS	18	4	22.2
FR9301624	CORNICHE VAROISE	34	4	11.8
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	4	36.4
FR9400616	JUNIPERAIE DE PORTO POLLO ET PLAGE DE CUPABIA	9	3	33.3
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9400619	CAMPO DELL'ORO (AJACCIO)	3	3	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400577	RIVIERE ET VALLEE DU FANGO	249	2	0.8
FR9400594	SITES A ANCHUSA CRISPA DE L'EMBOUCHURE DU RIZZANESE ET D'OLMETO	5	2	40.0
FR9400610	EMBOUCHURE DU TARAVO, PLAGE DE TENUTELLA ET ETANG DE TANCHICCIA	9	2	22.2
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9400586	EMBOUCHURE DU STABIACCU, DOMAINE PUBLIC MARITIME ET ÎLOT ZIGLIONE	6	1	16.7
FR9400593	ROCCAPINA-ORTOLO	24	1	4.2
FR9400599	STRETTES DE ST FLORENT	6	1	16.7
FR9400602	BASSE VALLÉE DU TAVIGNANO	55	1	1.8
	FRANCE TOTAL:	1784	506	28.4
ITALY				
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	43	51.2
ITB020041	ENTROTERRA E ZONA COSTIERA TRA BOSA, CAPO MARARGIU E PORTO TANGONE	337	25	7.4
ITA010029	MONTE COFANO, CAPO SAN VITO E MONTE SPARAGIO	218	24	11.0
IT51A0023	ISOLA DEL GIGLIO	34	23	67.6
IT51A0026	LAGUNA DI ORBETELLO	58	23	39.7
ITB010042	CAPO CACCIA (CON LE ISOLE FORADADA E PIANA) E PUNTA DEL GIGLIO	75	19	25.3
ITB033036	COSTA DI CUGLIERI	41	18	43.9
ITA070001	FOCE DEL FIUME SIMETO E LAGO GORNALUNGA	37	16	43.2
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	15	1.9
ITA010028	STAGNONE DI MARSALA E SALINE DI TRAPANI - AREA MARINA E TERRESTRE	55	15	27.3
ITA070029	BIVIERE DI LENTINI, TRATTO MEDIANO E FOCE DEL FIUME SIMETO E AREA ANTISTANTE LA	94	15	16.0
ITB010003	STAGNO E GINEPRETO DI PLATAMONA	28	15	53.6
IT5160012	MONTE CAPANNE E PROMONTORIO DELL'ENFOLA	95	13	13.7
IT5160013	ISOLA DI PIANOSA	21	13	61.9
IT5160016	ISOLA DI PIANOSA - AREA TERRESTRE E MARINA	22	13	59.1
ITB010043	COSTE E ISOLETTE A NORD OVEST DELLA SARDEGNA	48	13	27.1
ITA010017	CAPO SAN VITO, MONTE MONACO, ZINGARO, FARAGLIONI SCOPELLO, MONTE SPARACIO	108	12	11.1
ITB013044	CAPO CACCIA	51	12	23.5
ITB023037	COSTA E ENTROTERRA DI BOSA, SUNI E MONTRESTA	126	12	9.5
IT5160014	ISOLA DI MONTECRISTO	20	11	55.0
IT5160017	ISOLA DI MONTECRISTO E FORMICA DI MONTECRISTO - AREA TERRESTRE E MARINA	20	11	55.0
ITA070004	TIMPA DI ACIREALE	13	11	84.6

Code	Name	PA cells	PSA cells	Perc. PSA
ITA030044	ARCIPELAGO DELLE EOLIE - AREA MARINA E TERRESTRE	197	10	5.1
ITB010004	FOCI DEL COGHINAS	38	10	26.3
ITA010007	SALINE DI TRAPANI	25	9	36.0
IT5160102	ELBA ORIENTALE	83	8	9.6
ITA010016	MONTE COFANO E LITORALE	13	8	61.5
ITB011155	LAGO DI BARATZ - PORTO FERRO	25	8	32.0
IT9320106	STECCATO DI CUTRO E COSTA DEL TURCHESE	16	7	43.8
ITA090008	CAPO MURRO DI PORCO, PENISOLA DELLA MADDALENA E GROTTA PELLEGRINO	9	7	77.8
ITB032228	IS ARENAS	20	7	35.0
IT9320302	MARCHESATO E FIUME NETO	809	6	0.7
ITA010025	FONDALI DEL GOLFO DI CUSTONACI	11	6	54.5
ITA090026	FONDALI DI BRUCOLI - AGNONE	12	6	50.0
ITB010001	ISOLA ASINARA	86	6	7.0
ITB010082	ISOLA DELL'ASINARA	91	6	6.6
IT51A0028	DUNA DI FENIGLIA	13	5	38.5
IT6010018	LITORALE A NORD OVEST DELLE FOCI DEL FIORA	12	5	41.7
ITA010010	MONTE SAN GIULIANO	20	5	25.0
ITA030012	LAGUNA DI OLIVERI - TINDARI	9	5	55.6
ITA030033	CAPO CALAVÀ	6	5	83.3
ITA070028	FONDALI DI ACICASTELLO (ISOLA LACHEA - CICLOPI)	7	5	71.4
ITB030038	STAGNO DI PUTZU IDU (SALINA MANNA E PAULI MARIGOSA)	10	5	50.0
ITB040030	CAPO PECORA	55	5	9.1
IT51A0033	LAGO DI BURANO	12	4	33.3
IT9310304	ALTO IONIO COSENTINO	381	4	1.0
IT9350160	SPIAGGIA DI BRANCALEONE	5	4	80.0
ITA010001	ISOLE DELLO STAGNONE DI MARSALA	19	4	21.1
ITA010021	SALINE DI MARSALA	14	4	28.6
ITA010026	FONDALI DELL'ISOLA DELLO STAGNONE DI MARSALA	16	4	25.0
ITA010027	ARCIPELAGO DELLE EGADI - AREA MARINA E TERRESTRE	77	4	5.2
ITA020014	MONTE PELLEGRINO	15	4	26.7
ITA030003	RUPI DI TAORMINA E MONTE VENERETTA	14	4	28.6
ITB012211	ISOLA ROSSA - COSTA PARADISO	66	4	6.1
ITB030035	STAGNO DI SALE 'E PORCUS	15	4	26.7
ITB034007	STAGNO DI SALE E' PORCUS	14	4	28.6
ITB040071	DA PISCINAS A RIU SCIVU	39	4	10.3
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6010019	PIAN DEI CANGANI	4	3	75.0
IT6010026	SALINE DI TARQUINIA	6	3	50.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT6010027	LITORALE TRA TARQUINIA E MONTALTO DI CASTRO	11	3	27.3
IT9310042	FIUMARA SARACENO	27	3	11.1
ITA030027	ISOLA DI VULCANO	33	3	9.1
ITA070003	LA GURNA	4	3	75.0
ITA090006	SALINE DI SIRACUSA E FIUME CIANE	13	3	23.1
ITA090014	SALINE DI AUGUSTA	3	3	100.0
ITB010002	STAGNO DI PILO E DI CASARACCIO	28	3	10.7
ITB013012	STAGNO DI PILO, CASARACCIO E SALINE DI STINTINO	24	3	12.5
ITB030036	STAGNO DI CABRAS	60	3	5.0
ITB034008	STAGNO DI CABRAS	50	3	6.0
ITB040029	COSTA DI NEBIDA	116	3	2.6
IT51A0031	LAGO DI BURANO	7	2	28.6
IT6030019	MACCHIATONDA	6	2	33.3
IT6030027	CASTEL PORZIANO (FASCIA COSTIERA)	14	2	14.3
IT6030084	CASTEL PORZIANO (TENUTA PRESIDENZIALE)	81	2	2.5
IT9310043	FIUMARA AVENA	22	2	9.1
IT9350138	CALANCHI DI MARO SIMONE	4	2	50.0
ITA010003	ISOLA DI LEVANZO	12	2	16.7
ITA010004	ISOLA DI FAVIGNANA	33	2	6.1
ITA010015	COMPLESSO MONTI DI CASTELLAMMARE DEL GOLFO (TP)	44	2	4.5
ITA010024	FONDALI DELL'ISOLA DI FAVIGNANA	36	2	5.6
ITA030029	ISOLA DI SALINA (STAGNO DI LINGUA)	20	2	10.0
ITA030030	ISOLA DI LIPARI	53	2	3.8
ITA030031	ISOLA BELLA, CAPO TAORMINA E CAPO S. ANDREA	2	2	100.0
ITA030040	FONDALI DI TAORMINA - ISOLA BELLA	3	2	66.7
ITB042247	IS COMPINXIUS - CAMPO DUNALE DI BUGERRU - PORTIXEDDU	11	2	18.2
IT51A0032	DUNA DEL LAGO DI BURANO	7	1	14.3
IT6030004	VALLE DI RIO FIUME	26	1	3.8
IT6030020	TORRE FLAVIA	3	1	33.3
IT6030023	MACCHIA GRANDE DI FOCENE E MACCHIA DELLO STAGNETO	7	1	14.3
IT6030024	ISOLA SACRA	3	1	33.3
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
IT9320102	DUNE DI SOVERETO	6	1	16.7
IT9330105	FOCE DEL CROCCHIO - CROPANI	4	1	25.0
IT9350132	FIUMARA DI MELITO	8	1	12.5
IT9350141	CAPO S. GIOVANNI	2	1	50.0
IT9350142	CAPO SPARTIVENTO	4	1	25.0
IT9350144	CALANCHI DI PALIZZI MARINA	5	1	20.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT9350145	FIUMARA AMENDOLEA (INCLUSO ROGHUDI, CHORIO E ROTA GRECO)	25	1	4.0
IT9350171	SPIAGGIA DI PILATI	1	1	100.0
ITA030024	ISOLA DI FILICUDI	15	1	6.7
ITA030036	RISERVA NATURALE DEL FIUME ALCANTARA	42	1	2.4
ITA030041	FONDALI DELL'ISOLA DI SALINA	5	1	20.0
ITA070002	RISERVA NATURALE FIUME FIUMEFREDDO	3	1	33.3
ITA070006	ISOLE DEI CICLOPI	2	1	50.0
ITA090007	CAVA GRANDE DEL CASSIBILE, CAVA CINQUE PORTE, CAVA E BOSCO DI BAULI	89	1	1.1
ITA090013	SALINE DI PRIOLO	3	1	33.3
ITB013019	ISOLE DEL NORD - EST TRA CAPO CERASO E STAGNO DI SAN TEODORO	67	1	1.5
ITB020012	BERCHIDA E BIDDEROSA	37	1	2.7
ITB020013	PALUDE DI OSALLA	23	1	4.3
ITB030080	ISOLA DI MAL DI VENTRE E CATALANO	18	1	5.6
ITB040031	MONTE ARCUENTU E RIO PISCINAS	138	1	0.7
ITB042250	DA IS ARENAS A TONNARA (MARINA DI GONNESA)	8	1	12.5
	ITALY TOTAL:	5948	670	11.3
	OVERALL NATURA 2000 TOTAL:	12542	3163	25.2

Table C.8: *Diplotaxis ibicensis* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES000008	CAP ENDERROCAT-CAP BLANC	80	80	100.0	64	80.0
ES000008	SES SALINES D'EIVISSA I FORMENTERA	76	76	100.0	47	61.8
ES531003	CAP LLENTRISCA-SA TALAIA	50	50	100.0	43	86.0
ES000008	ARXIPÈLAG DE CABRERA	75	66	88.0	37	49.3
ES531010	ES AMUNTS D'EIVISSA	36	36	100.0	33	91.7
ES531011	NORD DE SANT JOAN	26	26	100.0	24	92.3
ES000003	ES TRENC-SALOBRAR DE CAMPOS	26	26	100.0	22	84.6
ES000003	S'ALBUFERA DE MALLORCA	39	32	82.1	20	51.3
ES000007	COSTA BRAVA DE MALLORCA	143	29	20.3	20	14.0
ES000024	COSTA DELS AMUNTS	21	21	100.0	20	95.2
ES531003	XARRACA	19	19	100.0	16	84.2
ES521301	PENYA-SEGATS DE LA MARINA	31	22	71.0	15	48.4
ES000007	CAP DE CALA FIGUERA	20	20	100.0	14	70.0
ES531007	DE CALA DE SES ORTIGUES A CALA ESTEL-LENCS	23	23	100.0	13	56.5
ES531003	SERRA GROSSA	25	25	100.0	11	44.0
ES531010	COSTA DE L'OEST D'EIVISSA	26	26	100.0	11	42.3
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES531008	PORT DES CANONGE	14	14	100.0	10	71.4
ES000022	L'ALBUFERETA	10	10	100.0	9	90.0
ES000022	CAP DE SES SALINES	60	7	11.7	7	11.7
ES531000	BADIES DE POLLENÇA I ALCÚDIA	50	14	28.0	7	14.0
ES000022	SA DRAGONERA	15	15	100.0	6	40.0
ES000022	LA TRAPA	10	10	100.0	6	60.0
ES531000	ES GALATZÓ-S'ESCLOP	36	36	100.0	6	16.7
ES531001	PUIG DE SANT MARTÍ	6	6	100.0	6	100.0
ES531008	S'ESTACA-PUNTA DE DEIÀ	13	10	76.9	6	46.2
ES531007	SERRAL D'EN SALAT	6	6	100.0	5	83.3
ES531010	ÀREA MARINA DE TAGOMAGO	6	6	100.0	5	83.3
ES531011	ÀREA MARINA PLATJA DE MIGJORN	22	10	45.5	5	22.7
ES000007	ES VEDRÀ-ES VEDRANELL	6	6	100.0	4	66.7
ES000008	TAGOMAGO	3	3	100.0	3	100.0
ES531002	CAP DE BARBARIA	18	3	16.7	3	16.7
ES531003	PORROIG	3	3	100.0	3	100.0
ES531009	FORMENTOR	7	3	42.9	3	42.9
ES531010	ÀREA MARINA DE CALA SAONA	4	4	100.0	3	75.0
ES000022	SA FORADADA	5	2	40.0	2	40.0
ES531002	LA MOLA	27	3	11.1	2	7.4
ES531008	ES BOIXOS	15	15	100.0	2	13.3

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES531010	ÀREA MARINA DEL CAP MARTINET	7	7	100.0	2	28.6
ES531003	BASSES DE LA MARINA DE LLUCMAJOR	3	3	100.0	1	33.3
ES531005	COVA DE CAL PESSO	1	1	100.0	1	100.0
ES531005	COVA DE LLENAIRE	1	1	100.0	1	100.0
ES531012	BASSA DE FORMENTERA	1	1	100.0	1	100.0
ES000022	SA COSTERA	14	1	7.1	0	0.0
ES000024	ILLOTS DE SANTA EULÀRIA, RODONA I ES CANÀ	2	2	100.0	0	0.0
ES000037	MOLA DE SON PACS	5	5	100.0	0	0.0
ES000037	PUIG DES BOIXOS	7	7	100.0	0	0.0
ES000037	PUIG DE SES FITES	8	8	100.0	0	0.0
ES000038	PUIG DE S'EXTREMERA	4	4	100.0	0	0.0
ES000038	PUIG GROS	20	20	100.0	0	0.0
ES000038	ALARÓ	4	4	100.0	0	0.0
ES000038	PUIG DES CASTELL	6	6	100.0	0	0.0
ES000043	PLA DE SA MOLA	22	22	100.0	0	0.0
ES000044	DES TEIX AL PUIG DE SES FITES	32	32	100.0	0	0.0
ES000044	D'ALFABIA A BINIARROI	112	112	100.0	0	0.0
ES000044	DE LA SERRA DE L'ESPERÓ AL PENYAL ALT	34	34	100.0	0	0.0
ES531000	ES TEIX	18	18	100.0	0	0.0
ES531001	COMUNA DE BUNYOLA	15	15	100.0	0	0.0
ES531002	FITA DES RAM	9	9	100.0	0	0.0
ES531002	CIMALS DE LA SERRA	135	129	95.6	0	0.0
ES531004	COVA DE LES MARAVELLES	1	1	100.0	0	0.0
ES531004	AVENC D'EN CORBERA	1	1	100.0	0	0.0
ES531004	COVA DE SA GUITARRETA	1	1	100.0	0	0.0
ES531004	COVA DES PAS DE VALLGORNERA	1	1	100.0	0	0.0
ES531005	COVA DE CAN SION	1	1	100.0	0	0.0
ES531006	COVA MORELLA	1	1	100.0	0	0.0
ES531006	COVA NOVA DE SON LLUÍS	1	1	100.0	0	0.0
ES531006	ES BUFADOR DE SON BERENGUER	1	1	100.0	0	0.0
ES531006	COVA DE CAN MILLO O DE COA NEGRINA	1	1	100.0	0	0.0
ES531006	AVENC DE SON POU	1	1	100.0	0	0.0
ES531007	PUIG DE NA BAUÇÀ	34	34	100.0	0	0.0
ES531008	PUIGPUNYENT	14	14	100.0	0	0.0
ES531008	MONCAIRE	10	4	40.0	0	0.0
ES531008	MONNÀBER	2	2	100.0	0	0.0
ES531008	GORG BLAU	6	6	100.0	0	0.0
ES531008	BINIARROI	11	11	100.0	0	0.0
ES531009	PUIG D'ALARÒ-PUIG DE S'ALCADENA	12	12	100.0	0	0.0
ES531009	MOSSA	11	10	90.9	0	0.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES531009	MUNTANYES DE POLLENÇA	54	54	100.0	0	0.0
ES531010	RANDA	23	23	100.0	0	0.0
ES531010	XORRIGO	18	18	100.0	0	0.0
ES531010	ÀREA MARINA CAP DE CALA FIGUERA	1	1	100.0	0	0.0
	SPAIN TOTAL:	1733	1418	81.8	531	30.6
	OVERALL NATURA 2000 TOTAL:	1733	1418	81.8	531	30.6

Table C.9: *Diplotaxis ibicensis* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
902531	UNESCO-MAB Biosphere Reserve	Gouraya	18	9	50.0
9747	National Park	Gouraya	18	9	50.0
26620	UNESCO-MAB Biosphere Reserve	El Kala	897	6	0.7
9741	National Park	El Kala	897	6	0.7
14909	Marine Park	El Kala	897	6	0.7
72362	National Park	Tigzirt	3	3	100.0
		ALGERIA TOTAL:	2730	39	1.4
		OVERALL NORTH AFRICAN TOTAL:	2730	39	1.4

Euphorbia squamigera

Table C.10: *Euphoriba squamigera* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000388	SIERRA DE ALCARAZ Y SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	2227	2173	97.6
ES4210008	SIERRA DE ALCARAZ Y SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	2213	2159	97.6
ES6140004	SIERRA NEVADA	1925	1925	100.0
ES0000035	SIERRAS DE CAZORLA, SEGURA Y LAS VILLAS	2294	1563	68.1
ES0000212	SIERRA DE MARTÉS-MUELA DE CORTES	1554	1554	100.0
ES0000449	ALTO TURIA Y SIERRA DEL NEGRETE	1126	897	79.7
ES0000159	HOCES DEL CABRIEL, GUADAZAON Y OJOS DE MOYA	950	804	84.6
ES4230013	HOCES DEL CABRIEL, GUADAZAÓN Y OJOS DE MOYA	926	780	84.2
ES5233040	MUELA DE CORTES Y EL CAROCHE	690	690	100.0
ES6140001	SIERRA DE BAZA	608	608	100.0
ES6110008	SIERRAS DE GADOR Y ENIX	598	590	98.7
ES6140005	SIERRAS DEL NORDESTE	572	569	99.5
ES0000453	MUNTANYES DE LA MARINA	557	557	100.0
ES5140011	SISTEMA PRELITORAL MERIDIONAL	680	507	74.6
ES6170007	SIERRAS DE TEJEDA, ALMIJARA Y ALHAMA	480	478	99.6
ES0000468	SERRÀ D'ESPADÀ	751	451	60.1
ES5233011	SIERRAS DE MARTÉS Y EL AVE	423	423	100.0
ES0000046	CABO DE GATA-NIJAR	477	416	87.2
ES0000298	MATARRAÑA - AIGUABARREIX	434	413	95.2
ES6110005	SIERRA DE CABRERA-BEDAR	413	407	98.5
ES0000472	HOCES DEL CABRIEL	401	396	98.8
ES0000153	AREA ESTEPARIA DEL ESTE DE ALBACETE	378	378	100.0
ES0000265	SIERRA DEL MOLINO, EMBALSE DEL QUIPAR Y LLANOS DEL CAGITAN	340	340	100.0
ES0000262	SIERRAS DEL GIGANTE-PERYCAI, LOMAS DEL BUITRE-RIO LUCHENA Y SIERRA DE LA TORRECI	332	332	100.0
ES6140008	SIERRA DE LOJA	330	330	100.0
ES0000261	SIERRA DE ALMENARA, MORERAS Y CABO COPE	327	327	100.0
ES6110006	RAMBLAS DE GERGAL, TABERNAS Y SUR DE SIERRA ALHAMILLA	324	322	99.4
ES5140009	TIVISSA-VANDELLÒS-LLABERIA	321	319	99.4
ES0000031	SIERRA DE GRAZALEMA	609	302	49.6
ES6110003	SIERRA MARIA - LOS VELEZ	295	295	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000267	SIERRA DE BURETE, LAVIA Y CAMBRÓN	288	288	100.0
ES5233009	SIERRA DEL NEGRETE	285	285	100.0
ES0000194	OTEROS-CAMPOS	380	280	73.7
ES0000474	SERRES DE MARIOLA I EL CARRASCAL DE LA FONT ROJA	278	278	100.0
ES5222001	SERRA D'ESPADÀ	364	275	75.5
ES6200035	SIERRA DE LA ALMENARA	273	273	100.0
ES0000458	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	260	260	100.0
ES0000266	SIERRA DE MORATALLA	258	258	100.0
ES6140006	SIERRA DE ARANA	256	256	100.0
ES0000023	L'ALBUFERA	255	255	100.0
ES0000471	L'ALBUFERA	255	255	100.0
ES0000469	SERRA CALDERONA	253	251	99.2
ES0000213	SERRES DE MARIOLA I EL CARRASCAR DE LA FONT ROJA	246	246	100.0
ES5232002	SERRA CALDERONA	240	240	100.0
ES4210001	HOCES DEL RIO JUCAR	239	239	100.0
ES5213019	AITANA, SERRELLA I PUIGCAMPANA	239	239	100.0
ES0000387	HOCES DEL RIO JUCAR	238	238	100.0
ES6170006	SIERRA DE LAS NIEVES	259	234	90.3
ES6170010	SIERRAS BERMEJA Y REAL	382	229	59.9
ES0000173	SIERRA ESPUÑA	223	223	100.0
ES5232006	ALTO TÚRIA	262	219	83.6
ES5233012	VALLE DE AYORA Y SIERRA DEL BOQUERÓN	219	219	100.0
ES5140006	SERRES DE CARDÓ- EL BOIX	217	217	100.0
ES5233010	HOCES DEL CABRIEL	219	214	97.7
ES5213042	VALLS DE LA MARINA	212	212	100.0
ES5233045	SERRA D'ENGUERA	211	211	100.0
ES6200004	SIERRAS Y VEGA ALTA DEL SEGURA Y RÍOS ALHÁRABE Y MORATALLA	211	211	100.0
ES0000024	DOÑANA	1310	203	15.5
ES0000269	MONTE EL VALLE Y SIERRAS DE ALTAHONA Y ESCALONA	196	196	100.0
ES5212008	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	191	191	100.0
ES5233044	SIERRA DE MALACARA	185	185	100.0
ES5140017	SERRA DE MONTSANT-PAS DE L'ASE	262	177	67.6
ES6140002	SIERRA DE CASTRIL	169	168	99.4
ES6200002	CARRASCOY Y EL VALLE	168	168	100.0
ES6110004	SIERRA DEL OSO	166	166	100.0
ES6140003	SIERRA DE HUETOR	158	158	100.0
ES0000020	DELTA DE L'EBRE	223	153	68.6
ES0000047	DESIERTO DE TABERNAS	152	152	100.0
ES6200018	SIERRA DE LA MUELA	152	152	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5223055	SERRA D'EN GALCERÀN	169	151	89.3
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	149	100.0
ES6170016	VALLE DEL RIO DEL GENAL	290	149	51.4
ES0000465	L'ALT MAESTRAT, TINENÇA DE BENIFASSÀ, TURMELL I VALLIVANA	1107	148	13.4
ES0000461	SERRES DEL SUD D'ALACANT	142	142	100.0
ES0000264	SIERRA DE LA MUELA Y CABO TIÑOSO	147	136	92.5
ES0000464	SIERRA ESCALONA Y DEHESA DE CAMPOAMOR	136	136	100.0
ES6170012	SIERRA DE CAMAROLOS	132	130	98.5
ES5213054	ELS ALFORINS	128	128	100.0
ES6140007	SIERRAS DEL CAMPANARIO Y LAS CABRAS	136	128	94.1
ES6200026	SIERRA DE RICOTE-LA NAVELA	127	127	100.0
ES5233001	TINENÇA DE BENIFASSÀ, TURMELL I VALLIVANA	571	125	21.9
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	122	100.0
ES0000257	SIERRAS DE RICOTE Y LA NAVELA	121	121	100.0
ES6200003	SIERRA DE LA PILA	119	119	100.0
ES0000457	SIERRA DE SALINAS	117	117	100.0
ES0000073	COSTA BRAVA DE MALLORCA	143	116	81.1
ES5213039	SIERRA DE SALINAS	115	115	100.0
ES0000045	SIERRA ALHAMILLA	111	111	100.0
ES0000174	SIERRA DE LA PILA	109	109	100.0
ES6200017	SIERRA DE VILLAFUERTE	109	109	100.0
ES5140012	TOSSALS D'ALMATRET I RIBA ROJA	108	108	100.0
ES2430097	RÍO MATARRANYA	106	106	100.0
ES6200045	RÍO MULA Y PLIEGO	104	104	100.0
ES6200015	LA MUELA Y CABO TIÑOSO	110	103	93.6
ES0000452	MECA-MUGRÓN-SAN BENITO	98	98	100.0
ES0000444	SERRA D'IRTA	105	94	89.5
ES5223036	SERRA D'IRTA	105	94	89.5
ES6110011	SIERRA DEL ALTO DE ALMAGRO	94	94	100.0
ES0000227	MUNTANYES D'ARTÀ	129	92	71.3
ES0000455	ELS ALFORINS	92	92	100.0
ES6110013	CALARES DE SIERRA DE LOS FILABRES	91	91	100.0
ES0000365	PÁRAMO LEONES	90	90	100.0
ES6200009	SIERRA DE EL CARCHE	86	86	100.0
ES6110012	SIERRAS ALMAGRERA, DE LOS PINOS Y EL AGUILON	87	84	96.6
ES0000441	D'ALFABIA A BINIARROI	112	83	74.1
ES5233013	SERRA DE CORBERA	83	83	100.0
ES5140005	SERRA DE MONTSIÀ	83	82	98.8
ES0000049	LOS ALCORNOCALES	1844	81	4.4
ES0000366	VALDERÍA-JAMUZ	134	79	59.0
ES5213022	SERRA DE CREVILLENT	78	78	100.0
ES5212012	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	77	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES6200034	LOMAS DEL BUITRE Y RÍO LUCHENA	77	77	100.0
ES0000268	SALADARES DEL GUADALENTIN	76	76	100.0
ES0000463	CABEÇO D'OR I LA GRANA	74	74	100.0
ES5232007	RIU XÚQUER	74	74	100.0
ES6200036	SIERRA DEL BUEY	74	74	100.0
ES5120007	CAP DE CREUS	155	73	47.1
ES6200023	SIERRA DE LA TERCIA	73	73	100.0
ES5140015	RIU SIURANA I PLANES DEL PRIORAT	72	71	98.6
ES6170011	SIERRA BLANCA	87	71	81.6
ES4130079	RIBERAS DEL RÍO ESLA Y AFLUENTES	146	70	47.9
ES6200014	SALADARES DEL GUADALENTÍN	70	70	100.0
ES4230002	SIERRAS DE TALAYUELAS Y ALIAGUILLA	115	69	60.0
ES6200043	RÍO QUÍPAR	69	69	100.0
ES0000140	BAHIA DE CADIZ	154	68	44.2
ES0000196	ESTEPAS DE YECLA	67	67	100.0
ES6200019	SIERRA DEL GAVILÁN	66	66	100.0
ES2420118	RÍO ALGARS	65	65	100.0
ES0000081	CAP ENDERROCAT-CAP BLANC	80	64	80.0
ES6200020	CASA ALTA-LAS SALINAS	63	63	100.0
ES6200022	SIERRA DEL GIGANTE	61	61	100.0
ES0000059	LLACUNES DE LA MATA I TORREVIEJA.	60	60	100.0
ES6200016	REVOLCADORES	60	60	100.0
ES0000337	ESTRECHO	160	58	36.2
ES5232003	CURS MITJÀ DEL RIU PALÀNCIA	93	58	62.4
ES5213020	SERRES DEL FERRER I BÈRNIA	57	57	100.0
ES6200047	SIERRA DE LA TORRECILLA	57	57	100.0
ES0000460	RIU MONTNEGRE	56	56	100.0
ES6130002	SIERRA SUBBETICA	386	55	14.2
ES0000230	LA VALL	74	53	71.6
ES4210004	LAGUNAS SALADAS DE PETROLA Y SALOBREJO Y COMPLEJO LAGUNAR DE CORRAL RUBIO	53	53	100.0
ES0000019	AIGUAMOLLS DE L'ALT EMPORDÀ	89	52	58.4
ES0000182	VALCUERNA, SERRETA NEGRA Y LIBEROLA	464	51	11.0
ES0000228	CAP DE SES SALINES	60	51	85.0
ES5140003	RIBERA DE L'ALGARS	51	51	100.0
ES6200011	SIERRA DE LAS MORERAS	50	50	100.0
ES0000231	DELS ALOCS A FORNELLS	52	49	94.2
ES5233041	SERRA DE LA SAFOR	49	49	100.0
ES0000446	DESERT DE LES PALMES	48	48	100.0
ES0000456	MORATILLAS-ALMELA	48	48	100.0
ES6160007	SIERRA MAGINA	243	48	19.8
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	47	61.8
ES5221002	DESERT DE LES PALMES	47	47	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5140023	SECANS DEL MONTSIÀ	46	46	100.0
ES5310029	NA BORGES	69	46	66.7
ES5310032	CAP LLENTRISCA-SA TALAIA	50	46	92.0
ES6200001	CALBLANQUE, MONTE DE LAS CENIZAS Y PEÑA DEL ÁGUILA	52	45	86.5
ES6200021	SIERRA DE LAVIA	44	44	100.0
ES6110002	KARST EN YESOS DE SORBAS	43	43	100.0
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES6140015	BARRANCOS DEL RIO DE AGUAS BLANCAS	42	42	100.0
ES0000120	SALINAS DE SANTA POLA.	44	41	93.2
ES0000058	EL FONDO D'ELX-CREVILLENT	39	39	100.0
ES0000195	HUMEDAL DE AJAUQUE Y RAMBLA SALADA	39	39	100.0
ES4130065	RIBERAS DEL RÍO ÓRBIGO Y AFLUENTES	126	39	31.0
ES5310113	LA VALL	46	39	84.8
ES6200046	SIERRA DE ENMEDIO	39	39	100.0
ES0000445	PLANIOLS-BENASQUES	38	38	100.0
ES5120016	EL MONTGRÍ- LES MEDES - EL BAIX TER	77	38	49.4
ES6150005	MARISMAS DE ISLA CRISTINA	43	38	88.4
ES6200029	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	38	54.3
ES0000260	MAR MENOR	67	37	55.2
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	37	92.5
ES4210011	SALADARES DE CORDOVILLA Y AGRAMON Y LAGUNA DE ALBORAJ	37	37	100.0
ES5211007	MONTGÓ	40	37	92.5
ES5310027	CIMALS DE LA SERRA	135	37	27.4
ES0000038	S'ALBUFERA DE MALLORCA	39	36	92.3
ES0000237	DES CANUTELLS A LLUCALARI	45	36	80.0
ES5310008	ES GALATZÓ-S'ESCLOP	36	36	100.0
ES6200039	CABEZO DE LA JARA Y RAMBLA DE NOGALTE	36	36	100.0
ES0000217	PENILLANURAS-CAMPOS NORTE	169	35	20.7
ES4230005	SABINARES DE CAMPILLOS-SIERRA Y VALDEMORILLO DE LA SIERRA	185	35	18.9
ES5213026	SIERRA DE ORIHUELA	35	35	100.0
ES5140002	SERRA DE GODALL	34	34	100.0
ES5222004	CURS ALT DEL RIU MILLARS	165	34	20.6
ES5310079	PUIG DE NA BAUÇÀ	34	34	100.0
ES0000259	SIERRA DE MOJANTES	33	33	100.0
ES0000443	SUD DE CIUTADELLA	38	33	86.8
ES2420099	SIERRA DE VIZCUERNO	35	33	94.3
ES4130145	LAGUNAS DE LOS OTEROS	58	33	56.9
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES6200005	HUMEDAL DEL AJAUQUE Y RAMBLA SALADA	33	33	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	32	100.0
ES5140010	RIBERES I ILLES DE L'EBRE	32	32	100.0
ES5223007	MARJAL D'ALMENARA	32	32	100.0
ES6200006	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	32	80.0
ES0000032	TORCAL DE ANTEQUERA	31	31	100.0
ES0000440	DES TEIX AL PUIG DE SES FITES	32	30	93.8
ES0000235	DE S'ALBUFERA A LA MOLA	41	29	70.7
ES0000239	DE BINIGAUS A CALA MITJANA	48	29	60.4
ES2430096	RÍO GUADALOPE, VAL DE FABARA Y VAL DE PILAS	86	29	33.7
ES5130038	SECANS DEL SEGRIÀ I UTXESA	90	29	32.2
ES5233034	SIERRA DEL MUGRÓN	29	29	100.0
ES0000025	MARISMAS DEL ODIEL	92	28	30.4
ES4190067	RIBERAS DEL RÍO TERA Y AFLUENTES	240	28	11.7
ES5110013	SERRES DEL LITORAL CENTRAL	375	28	7.5
ES5140016	TOSSAL DE MONTAGUT	28	28	100.0
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	28	82.4
ES6200037	SIERRA DEL SERRAL	28	28	100.0
ES0000466	PENYAGOLOSA	612	27	4.4
ES5212004	RIU GORGOS	27	27	100.0
ES5232008	CURS MITJÀ DEL RIU ALBAIDA	27	27	100.0
ES6200028	RÍO CHÍCAMO	27	27	100.0
ES0000307	PUERTOS DE BECEITE	189	26	13.8
ES5120013	MASSÍS DE LES CADIRETES	122	26	21.3
ES5310092	MUNTANYES DE POLLENÇA	54	26	48.1
ES0000238	SON BOU I BARRANC DE SA VALL	29	25	86.2
ES5120014	L'ALBERA	225	25	11.1
ES5120015	LITORAL DEL BAIX EMPORDÀ	51	25	49.0
ES5310034	SERRA GROSSA	25	25	100.0
ES5310112	NORD DE SANT JOAN	26	25	96.2
ES0000147	MARJAL DE PEGO-OLIVA.	24	24	100.0
ES0000234	S'ALBUFERA DES GRAU	31	24	77.4
ES0000318	CABO BUSTO-LUANCO	138	24	17.4
ES5233030	MARJAL DE LA SAFOR	24	24	100.0
ES6200008	SIERRA SALINAS	24	24	100.0
ES4210010	SIERRA DE ABENUJ	23	23	100.0
ES5213018	PENYA-SEGATS DE LA MARINA	31	23	74.2
ES5310101	RANDA	23	23	100.0
ES6140010	SIERRA DE BAZA NORTE	23	23	100.0
ES6150006	MARISMAS DEL RIO PIEDRAS Y FLECHA DEL ROMPIDO	55	23	41.8
ES6200027	SIERRA DE ABANILLA	23	23	100.0
ES6200038	CUERDA DE LA SERRATA	23	23	100.0
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	22	84.6
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	22	75.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000233	D'ADDAIA A S'ALBUFERA	35	22	62.9
ES0000317	PENARRONDA-BARAYO	64	22	34.4
ES0000439	PLA DE SA MOLA	22	22	100.0
ES6140009	SIERRA NEVADA NOROESTE	22	22	100.0
ES6170009	SIERRAS DE ALCAPARAIN Y AGUAS	86	22	25.6
ES6170032	SIERRA BLANQUILLA	22	22	100.0
ES6200042	YESOS DE ULEA	22	22	100.0
ES6120008	LA BREÑA Y MARISMAS DEL BARBATE	71	21	29.6
ES6170004	LOS REALES DE SIERRA BERMEJA	22	21	95.5
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES4210016	SIERRA DEL RELUMBRAR Y ESTRIBACIONES DE ALCARAZ	2083	20	1.0
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	20	40.0
ES6150001	LAGUNA DEL PORTIL	23	20	87.0
ES0000263	LLANO DE LAS CABRAS	19	19	100.0
ES0000381	PUIG GROS	20	19	95.0
ES5222005	MARJAL DE NULES	19	19	100.0
ES0000048	PUNTA ENTINAS-SABINAR	39	18	46.2
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES5310102	XORRIGO	18	18	100.0
ES6200024	CABEZO DE ROLDÁN	22	18	81.8
ES6200041	RAMBLA DE LA ROGATIVA	18	18	100.0
ES5212007	SALERO Y CABECICOS DE VILLENA	17	17	100.0
ES5310024	LA MOLA	27	17	63.0
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	17	73.9
ES6170008	SIERRAS DE ABDALAJIS Y LA ENCANTADA SUR	51	17	33.3
ES6200012	CALNEGRE	18	17	94.4
ES2420119	ELS PORTS DE BESEIT	138	16	11.6
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5310009	ES TEIX	18	16	88.9
ES5310033	XARRACA	19	16	84.2
ES6140011	SIERRA DE CASTELL DE FERRO	17	16	94.1
ES6200025	SIERRA DE LA FAUSILLA	21	16	76.2
ES6200030	MAR MENOR	45	16	35.6
ES0000148	MARJAL DELS MOROS.	15	15	100.0
ES0000199	SIERRA DE LA FAUSILLA	20	15	75.0
ES0000442	DE LA SERRA DE L'ESPERÓ AL PENYAL ALT	34	15	44.1
ES0000470	MARJAL DELS MOROS	15	15	100.0
ES2420036	PUERTOS DE BECEITE	72	15	20.8
ES2420116	RÍO MEZQUÍN Y OSCUROS	26	15	57.7
ES2430033	EFESA DE LA VILLA	24	15	62.5
ES5213023	SIERRA DE CALLOSA DE SEGURA	15	15	100.0
ES6110010	FONDOS MARINOS LEVANTE ALMERIENSE	26	15	57.7

Code	Name	PA cells	PSA cells	Perc. PSA
ES6140012	LA MALA	15	15	100.0
ES6170003	DESFILADERO DE LOS GAITANES	37	15	40.5
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000145	MONDRAGÓ	15	14	93.3
ES0000146	DELTA DEL LLOBREGAT	28	14	50.0
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000240	COSTA SUD DE CIUTADELLA	25	14	56.0
ES2420114	SALADAS DE ALCAÑIZ	14	14	100.0
ES5213024	TABARCA	24	14	58.3
ES5213025	DUNES DE GUARDAMAR	19	14	73.7
ES5310080	PUIGPUNYENT	14	14	100.0
ES5310083	ES BOIXOS	15	14	93.3
ES6200040	CABEZOS DEL PERICÓN	14	14	100.0
ES6150004	LAGUNAS DE PALOS Y LAS MADRES	16	13	81.2
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	12	66.7
ES0000175	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	12	70.6
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES0000462	CLOT DE GALVANY	12	12	100.0
ES0000467	PRAT DE CABANES I TORREBLANCA	18	12	66.7
ES5211009	IFAC	14	12	85.7
ES5310010	COMUNA DE BUNYOLA	15	12	80.0
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310098	CALES DE MANACOR	16	12	75.0
ES6110007	LA SERRETA DE CABO DE GATA	12	12	100.0
ES6110014	ARTOS DE EL EJIDO	12	12	100.0
ES0000079	LA VICTÒRIA	16	11	68.8
ES0000162	SERRANIA DE CUENCA	2235	11	0.5
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	11	73.3
ES0000225	SA COSTERA	14	11	78.6
ES4230014	SERRANIA DE CUENCA	2187	11	0.5
ES5310091	MOSSA	11	11	100.0
ES5310104	COSTA DE L'OEST D'EIVISSA	26	11	42.3
ES6310001	CALAMOCARRO-BENZÚ	11	11	100.0
ES4190134	LAGUNAS DE TERA Y VIDRIALES	47	10	21.3
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6
ES5310081	PORT DES CANONGE	14	10	71.4
ES5310085	MONCAIRE	10	10	100.0
ES5310087	BÀLITX	12	10	83.3
ES0000226	L'ALBUFERETA	10	9	90.0
ES2410030	SERRETA NEGRA	188	9	4.8
ES5140001	LITORAL MERIDIONAL TARRAGONÍ	20	9	45.0
ES5140022	BARRANC DE SANTES CREUS	9	9	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310026	FITA DES RAM	9	9	100.0
ES5310068	CAP NEGRE	9	9	100.0
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	9	69.2
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES6110018	RIO ADRA	9	9	100.0
ES0000379	PUIG DE SES FITES	8	8	100.0
ES0000386	CAPELL DE FERRO	30	8	26.7
ES2410084	LIBEROLA-SERRETA NEGRA	86	8	9.3
ES5212006	LAGUNA DE SALINAS	8	8	100.0
ES5310090	PUIG D'ALARÒ-PUIG DE S'ALCADENA	12	8	66.7
ES6200044	SIERRA DE LAS VICTORIAS	8	8	100.0
ES0000378	PUIG DES BOIXOS	7	7	100.0
ES5110011	SERRES DEL LITORAL SEPTENTRIONAL	308	7	2.3
ES5212009	ALGEPSARS DE FINESTRAT	7	7	100.0
ES5213033	CABO ROIG	11	7	63.6
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES6110017	RIO ANTAS	7	7	100.0
ES6120013	SIERRA LIJAR	109	7	6.4
ES6150012	DEHESA DEL ESTERO Y MONTES DE MOGUER	49	7	14.3
ES6150019	BAJO GUADALQUIVIR	160	7	4.4
ES6200013	CABEZO GORDO	7	7	100.0
ES0000021	SECANS DE MAS DE MELONS-ALFÉS	94	6	6.4
ES0000207	PENILLANURAS-CAMPOS SUR	288	6	2.1
ES0000221	SA DRAGONERA	15	6	40.0
ES0000222	LA TRAPA	10	6	60.0
ES0000385	BARBATX	24	6	25.0
ES1120005	AS CATEDRAIS	17	6	35.3
ES5130040	SECANS DE MAS DE MELONS-ALFÉS	94	6	6.4
ES5140007	COSTES DEL TARRAGONÈS	14	6	42.9
ES5310015	PUIG DE SANT MARTÍ	6	6	100.0
ES5310093	FORMENTOR	7	6	85.7
ES6150003	ESTERO DE DOMINGO RUBIO	13	6	46.2
ES6200031	CABO COPE	6	6	100.0
ES0000377	MOLA DE SON PACS	5	5	100.0
ES0000383	PUIG DES CASTELL	6	5	83.3
ES5120010	LES GAVARRES	344	5	1.5
ES5213032	CAP DE LES HORTES	15	5	33.3
ES5222002	MARJAL DE PENÍSCOLA	5	5	100.0
ES5310076	SERRAL D'EN SALAT	6	5	83.3
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES6150029	ESTUARIO DEL RIO TINTO	18	5	27.8
ES6170005	SIERRA CRESTELLINA	12	5	41.7
ES6200010	CUATRO CALAS	6	5	83.3

Code	Name	PA cells	PSA cells	Perc. PSA
ES6200048	MEDIO MARINO	15	5	33.3
ES0000004	LAGUNAS DE VILLAFÁFILA	375	4	1.1
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000223	SA FORADADA	5	4	80.0
ES0000380	PUIG DE S'EXTREMERA	4	4	100.0
ES0000382	ALARÓ	4	4	100.0
ES0000384	BARRANC DE SANTA ANNA	4	4	100.0
ES5110007	RIU I ESTANYS DE TORDERA	38	4	10.5
ES5140014	MASSÍS DE BONASTRE	45	4	8.9
ES5140019	RIU GAIÀ	67	4	6.0
ES5233047	ULLALS DEL RIU VERD	4	4	100.0
ES5310028	ES BINIS	4	4	100.0
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES6110001	ALBUFERA DE ADRA	4	4	100.0
ES6150015	ISLA DE SAN BRUNO	8	4	50.0
ES6150018	RIO GUADIANA Y RIBERA DE CHANZA	97	4	4.1
ES6160008	CUENCAS DEL RUMBLAR, GUADALEN Y GUADALMENA	2071	4	0.2
ES6320002	BARRANCO DEL NANO	4	4	100.0
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000085	RIBADEO	39	3	7.7
ES0000224	MULETA	7	3	42.9
ES1200016	RÍA DEL EO	33	3	9.1
ES5120011	RIBERES DEL BAIX TER	80	3	3.8
ES5140008	MUNTANYES DE PRADES	379	3	0.8
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5310031	PORROIG	3	3	100.0
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	3	100.0
ES5310089	BINIARROI	11	3	27.3
ES5310099	PORTOCOLOM	5	3	60.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES6120006	MARISMAS DEL RIO PALMONES	4	3	75.0
ES6120017	PUNTA DE TRAFALGAR	7	3	42.9
ES6150002	ENEBRALES DE PUNTA UMBRIA	7	3	42.9
ES6150028	ESTUARIO DEL RIO PIEDRAS	14	3	21.4
ES6170002	ACANTILADOS DE MARO-CERRO GORDO	15	3	20.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000214	ILLOTS DE TABARCA	12	2	16.7
ES1120011	RÍA DE FOZ - MASMA	26	2	7.7
ES5110020	COSTES DEL GARRAF	12	2	16.7
ES5140004	SÈQUIA MAJOR	4	2	50.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5232005	LAVAJOS DE SINARCAS	2	2	100.0
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310084	TORRE PICADA	5	2	40.0
ES5310086	MONNÀBER	2	2	100.0
ES5310088	GORG BLAU	6	2	33.3
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES5310114	BINIGAFULL	2	2	100.0
ES5310115	ES MOLINET	2	2	100.0
ES5310120	ES CLOT DES GUIX	3	2	66.7
ES6120003	ESTUARIO DEL RIO GUADIARO	3	2	66.7
ES6120018	PINAR DE ROCHE	18	2	11.1
ES6140014	ACANTILADOS Y FONDOS MARINOS DE CALAHONDA-CASTELL DE FERRO	7	2	28.6
ES6150013	DUNAS DEL ODIEL	5	2	40.0
ES6160015	RIO GUADIANA MENOR - TRAMO SUPERIOR	2	2	100.0
ES6170028	RIO GUADALMEDINA	4	2	50.0
ES6170037	EL SALADILLO - PUNTA DE BAÑOS	5	2	40.0
ES6200007	ISLAS E ISLOTES DEL LITORAL MEDITERRÁNEO	4	2	50.0
ES6310002	ZONA MARÍTIMO-TERRESTRE DEL MONTE HACHO	6	2	33.3
ES6320001	ZONA MARÍTIMO TERRESTRE DE LOS ACANTILADOS DE AGUADÚ	2	2	100.0
ES0000181	LA RETUERTA Y SALADAS DE SÁSTAGO	463	1	0.2
ES0000197	ACANTILADOS DEL MONTE HACHO	4	1	25.0
ES0000215	OTEROS-CEA	76	1	1.3
ES0000389	RENTOS DE ORCHOVA Y VERTIENTES DEL TURIA	117	1	0.9
ES0000447	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES1120002	RÍO EO	59	1	1.7
ES2430082	MONEGROS	458	1	0.2
ES4180069	RIBERAS DEL RÍO CEA	92	1	1.1
ES4230001	RENTOS DE ORCHOVA Y VERTIENTES DEL TURIA	85	1	1.2
ES5120021	RIU FLUVIÀ	113	1	0.9
ES5130001	ELS BESSONS	17	1	5.9
ES5130013	AIGUABARREIG SEGRE-CINCA	50	1	2.0
ES5140020	GRAPISSAR DE LA MASIA BLANCA	4	1	25.0
ES5212010	ARENAL DE PETRER	1	1	100.0
ES5214002	TUNEL DE CANALS	1	1	100.0
ES5214004	COVA JOLIANA	1	1	100.0
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5223002	L'ALT MAESTRAT	525	1	0.2
ES5223005	ALT PALÀNCIA	314	1	0.3
ES5223037	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5224001	COVA OSCURA-ATZENETA DEL MAESTRAT	1	1	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5232009	SERRA DEL CASTELL DE XÀTIVA	1	1	100.0
ES5233049	COVA DE LES RATES PENADES (RÒTOVA)	1	1	100.0
ES5233051	COVA DE LES MERAVELLES DE LLOMBAI	1	1	100.0
ES5234001	COVA DEL SARDINER-SAGUNT	1	1	100.0
ES5234005	SIMA DE L'ÀGUILA-PICASSENT	1	1	100.0
ES5310040	COVA DE LES MARAVELLES	1	1	100.0
ES5310042	AVENC D'EN CORBERA	1	1	100.0
ES5310048	COVA DE SA GUITARRETA	1	1	100.0
ES5310050	COVA D'EN BESSÓ	1	1	100.0
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310061	COVA NOVA DE SON LLUÍS	1	1	100.0
ES5310062	ES BUFADOR DE SON BERENGUER	1	1	100.0
ES5310063	COVA DE CAN MILLO O DE COA NEGRINA	1	1	100.0
ES5310064	AVENC DE SON POU	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310123	BASSA DE FORMENTERA	1	1	100.0
ES6110016	RAMBLA DE AREJOS	1	1	100.0
ES6120019	RIO SALADO DE CONIL	18	1	5.6
ES6120028	RIO DE LA JARA	2	1	50.0
ES6150014	MARISMAS Y RIBERAS DEL TINTO	59	1	1.7
ES6170021	RIO GUADALMINA	1	1	100.0
ES6170022	RIO FUENGIROLA	7	1	14.3
ES6170030	CALAHONDA	7	1	14.3
ES6170034	RIO GUADALEVIN	2	1	50.0
ES6200032	MINAS DE LA CELIA	1	1	100.0
	SPAIN TOTAL:	68270	41523	60.8
FRANCE				
FR9310019	CAMARGUE	899	776	86.3
FR9301592	CAMARGUE	884	768	86.9
FR9301595	CRAU CENTRALE - CRAU SECHE	525	525	100.0
FR9310064	CRAU	493	493	100.0
FR9101406	PETITE CAMARGUE	405	374	92.3
FR9310069	GARRIGUES DE LANÇON ET CHAÎNES ALENTOUR	348	342	98.3
FR9312013	LES ALPILLES	333	332	99.7
FR9112015	COSTIERE NIMOISE	224	222	99.1
FR9301594	LES ALPILLES	223	222	99.6

Code	Name	PA cells	PSA cells	Perc. PSA
FR9301596	MARAIS DE LA VALLEE DES BAUX ET MARAIS D'ARLES	189	189	100.0
FR9112013	PETITE CAMARGUE LAGUNO-MARINE	208	186	89.4
FR9301589	LA DURANCE	413	153	37.0
FR9312003	LA DURANCE	450	153	34.0
FR9301590	LE RHONE AVAL	318	141	44.3
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	135	66.8
FR9112007	ETANGS DU NARBONNAIS	142	122	85.9
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	118	65.2
FR9301603	CHAINE DE L'ETOILE- MASSIF DU GARLABAN	139	116	83.5
FR9312001	MARAIS ENTRE CRAU ET GRAND RHÔNE	110	110	100.0
FR9112004	HAUTES GARRIGUES DU MONTPELLIERAIS	553	107	19.3
FR9400570	AGRIATES	151	105	69.5
FR9110080	MONTAGNE DE LA CLAPE	120	104	86.7
FR9101453	MASSIF DE LA CLAPE	113	103	91.2
FR9112018	ETANG DE THAU ET LIDO DE SETE A AGDE	110	98	89.1
FR9101440	COMPLEXE LAGUNAIRE DE BAGES-SIGEAN	106	93	87.7
FR9101408	ETANG DE MAUGUIO	102	90	88.2
FR9112001	CAMARGUE GARDOISE FLUVIO-LACUSTRE	90	90	100.0
FR9112017	ETANG DE MAUGUIO	102	90	88.2
FR9112022	EST ET SUD DE BEZIERS	94	84	89.4
FR9101463	COMPLEXE LAGUNAIRE DE SALSES	89	82	92.1
FR9112005	COMPLEXE LAGUNAIRE DE SALSES-LEUCATE	85	79	92.9
FR9101393	MONTAGNE DE LA MOURE ET CAUSSE D'AUMELAS	137	77	56.2
FR9112021	PLAINE DE VILLEVEYRAC-MONTAGNAC	74	74	100.0
FR9101410	ETANGS PALAVASIENS	100	73	73.0
FR9110042	ETANGS PALAVASIENS ET ÉTANG DE L'ESTAGNOL	100	73	73.0
FR9101405	LE PETIT RHONE	73	72	98.6
FR9312009	PLATEAU DE L'ARBOIS	68	68	100.0
FR9301601	COTE BLEUE - CHAINE DE L'ESTAQUE	84	67	79.8
FR9110108	BASSE PLAINE DE L'AUDE	72	63	87.5
FR9101411	HERBIERS DE L'ETANG DE THAU	67	59	88.1
FR9112020	PLAINE DE FABREGUES-POUSSAN	51	51	100.0
FR9301622	LA PLAINE ET LE MASSIF DES MAURES	450	51	11.3
FR9301578	LA SORGUES ET L'AUZON	97	50	51.5
FR9301613	RADE D'HYERES	141	48	34.0
FR9101439	COLLINES DU NARBONNAIS	45	45	100.0
FR9112006	ETANG DE LAPALME	55	45	81.8
FR9400568	CAP CORSE NORD ET ILE FINOCCHIAROLA, GIRAGLIA ET CAPENSE (COTE DE MACINAGGIO A C	47	44	93.6
FR9101435	BASSE PLAINE DE L'AUDE	47	42	89.4
FR9101436	COURS INFERIEUR DE L'AUDE	43	41	95.3

Code	Name	PA cells	PSA cells	Perc. PSA
FR9301605	MONTAGNE SAINTE VICTOIRE - FORET DE PEYROLLES - MONTAGNE DES UBACS - MONTAGNE D'	370	41	11.1
FR9301628	ESTEREL	124	38	30.6
FR9310020	ILES D'HYÈRES	130	38	29.2
FR9301597	MARAIS ET ZONES HUMIDES LIEES A L'ETANG DE BERRE	37	37	100.0
FR9301568	CORNICHES DE LA RIVIERA	48	32	66.7
FR9301608	MONT CAUME - MONT FARON - FORET DOMANIALE DES MORIERES	171	32	18.7
FR9101483	MASSIF DES ALBERES	103	31	30.1
FR9112023	MASSIF DES ALBERES	105	31	29.5
FR9101391	LE VIDOURLE	30	30	100.0
FR9310075	MASSIF DU PETIT LUBERON	262	30	11.5
FR9402013	PLATEAU DU CAP CORSE	40	30	75.0
FR9110111	BASSES CORBIÈRES	474	29	6.1
FR9301585	MASSIF DU LUBERON	287	29	10.1
FR9101465	COMPLEXE LAGUNAIRE DE CANET	31	28	90.3
FR9112025	COMPLEXE LAGUNAIRE DE CANET-SAINT NAZAIRE	31	28	90.3
FR9410098	URBINO	41	28	68.3
FR9112016	ETANG DE CAPESTANG	27	27	100.0
FR9301587	LE CALAVON ET L'ENCREME	83	27	32.5
FR9312015	ETANGS ENTRE ISTRES ET FOS	28	26	92.9
FR9412009	PLATEAU DU CAP CORSE	32	26	81.2
FR9410097	ILES FINOCCHIAROLA ET CÔTE NORD	27	24	88.9
FR9301626	VAL D'ARGENS	240	23	9.6
FR9400571	ETANG DE BIGUGLIA	37	23	62.2
FR9400577	RIVIERE ET VALLEE DU FANGO	249	23	9.2
FR9400592	VENTILEGNE-LA TRINITE DE BONIFACIO-FAZZIO	46	23	50.0
FR9402001	CAMPOMORO-SENETOSA	40	22	55.0
FR9410101	ETANG DE BIGUGLIA	35	22	62.9
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	22	55.0
FR9101441	COMPLEXE LAGUNAIRE DE LAPALME	31	21	67.7
FR9101388	GORGES DE L'HERAULT	287	20	7.0
FR9301627	EMBOUCHURE DE L'ARGENS	24	20	83.3
FR9310067	MONTAGNE SAINTE VICTOIRE	201	20	10.0
FR9101486	COURS INFERIEUR DE L'HERAULT	21	19	90.5
FR9101481	COTE ROCHEUSE DES ALBERES	28	17	60.7
FR9402017	GOLFE D'AJACCIO	66	17	25.8
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	17	25.8
FR9112008	CORBIERES ORIENTALES	311	16	5.1
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	16	76.2
FR9402012	CAPO DI FENO	29	15	51.7
FR9101392	LE LEZ	14	14	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	14	56.0
FR9412007	VALLÉE DU REGINO	56	14	25.0
FR9312005	SALINES DE L'ETANG DE BERRE	11	11	100.0
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	11	50.0
FR9400593	ROCCAPINA-ORTOLO	24	11	45.8
FR9402015	BOUCHES DE BONIFACIO, ILES DES MOINES	87	11	12.6
FR9410021	ILES LAVEZZI, BOUCHES DE BONIFACIO	111	11	9.9
FR9101412	ETANG DU BAGNAS	13	10	76.9
FR9101478	LE TECH	79	10	12.7
FR9110034	ETANG DU BAGNAS	12	10	83.3
FR9301610	CAP SICIE - SIX FOURS	18	10	55.6
FR9101493	EMBOUCHURE DU TECH ET GRAU DE LA MASSANE	14	8	57.1
FR9102005	AQUEDUC DE PEZENAS	8	8	100.0
FR9112034	CAP BEAR- CAP CERBERE	16	8	50.0
FR9312014	COLLE DU ROUET	151	8	5.3
FR9400572	MUCCHIATANA	9	8	88.9
FR9400601	ALISO-OLETTA	9	8	88.9
FR9112002	LE SALAGOU	173	7	4.0
FR9301567	VALLEE DU CARAI - COLLINES DE CASTILLON	73	7	9.6
FR9301571	RIVIERE ET GORGES DU LOUP	84	7	8.3
FR9301609	LA POINTE FAUCONNIERE	11	7	63.6
FR9301624	CORNICHE VAROISE	34	7	20.6
FR9312002	PRÉALPES DE GRASSE	312	7	2.2
FR9312018	FALAISES DE VAUFRÈGES	7	7	100.0
FR9400602	BASSE VALLÉE DU TAVIGNANO	55	7	12.7
FR9402016	POINTE DE SENETOSA ET PROLONGEMENTS	35	7	20.0
FR9101442	PLATEAU DE LEUCATE	9	6	66.7
FR9301572	DOME DE BIOT	6	6	100.0
FR9400588	SUBERAIE DE CECCIA/PORTO-VECCHIO	28	6	21.4
FR9400599	STRETTES DE ST FLORENT	6	6	100.0
FR9112030	PLATEAU DE LEUCATE	8	5	62.5
FR9400590	TRE PADULE DE SUARTONE, RONDINARA	11	5	45.5
FR9101389	PIC SAINT-LOUP	71	4	5.6
FR9101430	PLATEAU DE ROQUEHAUTE	4	4	100.0
FR9101433	LA GRANDE MAIRE	9	4	44.4
FR9102001	FRICHES HUMIDES DE TORREMILLA	4	4	100.0
FR9112035	COTE LANGUEDOCIENNE	44	4	9.1
FR9301998	BAIE DE LA CIOTAT	10	4	40.0
FR9312025	BASSE VALLÉE DU VAR	31	4	12.9
FR9400586	EMBOUCHURE DU STABIACCU, DOMAINE PUBLIC MARITIME ET ÎLOT ZIGLIONE	6	4	66.7

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	4	36.4
FR9400609	ILES ET POINTE BRUZZI, ETANGS DE CHEVANU ET D'ARBITRU	10	4	40.0
FR9400610	EMBOUCHURE DU TARAVO, PLAGE DE TENUTELLA ET ETANG DE TANCHICCIA	9	4	44.4
FR9402010	BAIE DE STAGNOLU, GOLFU DI SOGNU, GOLFE DE PORTO-VECCHIO	20	4	20.0
FR9301625	FORET DE PALAYSON - BOIS DU ROUET	82	3	3.7
FR9400591	PLATEAU DE PERTUSATO/ BONIFACIO ET ILES LAVEZZI	37	3	8.1
FR9400616	JUNIPERAIE DE PORTO POLLO ET PLAGE DE CUPABIA	9	3	33.3
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9400619	CAMPO DELL'ORO (AJACCIO)	3	3	100.0
FR9101431	MARE DU PLATEAU DE VENDRES	2	2	100.0
FR9101434	LES ORPELLIERES	7	2	28.6
FR9101487	GROTTE DE LA RATAPANADE	2	2	100.0
FR9301996	CAP FERRAT	19	2	10.5
FR9301999	COTE BLEUE MARINE	30	2	6.7
FR9312007	ILES MARSEILLAISES - CASSIDAIGNE	45	2	4.4
FR9312016	FALAISES DU MONT CAUME	7	2	28.6
FR9312017	FALAISES DE NIOLON	5	2	40.0
FR9400594	SITES A ANCHUSA CRISPA DE L'EMBOUCHURE DU RIZZANESE ET D'OLMETO	5	2	40.0
FR9402009	MARE TEMPORAIRE DE MUSELLA/BONIFACIO	2	2	100.0
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9101416	CARRIERES DE NOTRE-DAME DE L'AGENOUILLADE	1	1	100.0
FR9101464	CHATEAU DE SALSES	1	1	100.0
FR9102012	PROLONGEMENT EN MER DES CAP ET ETANG DE LEUCATE	4	1	25.0
FR9102014	BANCS SABLEUX DE L'ESPIGUETTE	16	1	6.2
FR9301573	BAIE ET CAP D'ANTIBES - ILES DE LERINS	18	1	5.6
FR9400569	CRETES DU CAP CORSE, VALLON DE SISCO	2	1	50.0
FR9400612	PUNTA CALCINA	1	1	100.0
FR9402011	ANCIENNES GALERIES DE MINES DE LOZARI/BELGODERE(SITE À CHAUVES-SOURIS)	1	1	100.0
	FRANCE TOTAL:	16476	9018	54.7
ITALY				
ITA030043	MONTI NEBRODI	819	553	67.5
ITA020048	MONTI SICANI, ROCCA BUSAMBRA E BOSCO DELLA FICUZZA	750	537	71.6
ITA020050	PARCO DELLE MADONIE	514	512	99.6
ITB043055	MONTE DEI SETTE FRATELLI	487	446	91.6

Code	Name	PA cells	PSA cells	Perc. PSA
IT9130007	AREA DELLE GRAVINE	359	247	68.8
ITA010029	MONTE COFANO, CAPO SAN VITO E MONTE SPARAGIO	218	197	90.4
ITA030038	SERRA DEL RE, MONTE SORO E BIVIERE DI CESARÒ	255	186	72.9
ITB041105	FORESTA DI MONTE ARCOSU	358	180	50.3
ITA050012	TORRE MANFRIA, BIVIERE E PIANA DI GELA	227	176	77.5
IT9110039	PROMONTORIO DEL GARGANO	874	155	17.7
ITB020014	GOLFO DI OROSEI	307	152	49.5
IT9110038	PALUDI PRESSO IL GOLFO DI MANFREDONIA	205	137	66.8
IT9110005	ZONE UMIDE DELLA CAPITANATA	202	134	66.3
ITB041106	MONTE DEI SETTE FRATELLI E SARRABUS	130	129	99.2
ITB020041	ENTROTERRA E ZONA COSTIERA TRA BOSA, CAPO MARARGIU E PORTO TANGONE	337	120	35.6
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	115	14.9
IT9130005	MURGIA DI SUD - EST	571	115	20.1
ITA020016	MONTE QUACELLA, MONTE DEI CERVI, PIZZO CARBONARA, MONTE FERRO, PIZZO OTIERO	112	112	100.0
ITA020049	MONTE PECORARO E PIZZO CIRINA	129	111	86.0
ITA030044	ARCIPELAGO DELLE EOLIE - AREA MARINA E TERRESTRE	197	111	56.3
ITA030014	PIZZO FAU, MONTE POMIERE, PIZZO BIDI E SERRA DELLA TESTA	109	109	100.0
IT5170002	SELVA PISANA	141	104	73.8
ITA010017	CAPO SAN VITO, MONTE MONACO, ZINGARO, FARAGLIONI SCOPELLO, MONTE SPARACIO	108	99	91.7
ITB040029	COSTA DI NEBIDA	116	99	85.3
ITA070005	BOSCO DI SANTO PIETRO	89	89	100.0
ITA090007	CAVA GRANDE DEL CASSIBILE, CAVA CINQUE PORTE, CAVA E BOSCO DI BAULI	89	88	98.9
IT51A0029	BOSCHI DELLE COLLINE DI CAPALBIO	87	87	100.0
IT9110008	VALLONI E STEPPE PEDEGARGANICHE	362	87	24.0
ITA020004	MONTE S. SALVATORE, MONTE CATARINECI, VALLONE MANDARINI, AMBIENTI UMIDI	84	84	100.0
ITA010030	ISOLA DI PANTELLERIA E AREA MARINA CIRCOSTANTE	101	81	80.2
ITA020017	COMPLESSO PIZZO DIPILO E QUERCETI SU CALCARE	77	77	100.0
ITA020023	RAFFO ROSSO, MONTE CUCCIO E VALLONE SAGANA	101	77	76.2
ITA070029	BIVIERE DI LENTINI, TRATTO MEDIANO E FOCE DEL FIUME SIMETO E AREA ANTISTANTE LA	94	77	81.9
ITA090009	VALLE DEL FIUME ANAPO, CAVAGRANDE DEL CALCINARA, CUGNI DI SORTINO	77	77	100.0
ITA020025	BOSCO DI S. ADRIANO	90	72	80.0
ITA040006	COMPLESSO MONTE TELEGRAFO E ROCCA FICUZZA	73	72	98.6
ITA060012	BOSCHI DI PIAZZA ARMERINA	72	72	100.0
IT6030084	CASTEL PORZIANO (TENUTA PRESIDENZIALE)	81	71	87.7

Code	Name	PA cells	PSA cells	Perc. PSA
ITB040023	STAGNO DI CAGLIARI, SALINE DI MACCHIAREDDU, LAGUNA DI SANTA GILLA	83	71	85.5
ITA010014	SCIARE DI MARSALA	70	68	97.1
IT5160102	ELBA ORIENTALE	83	67	80.7
IT5160012	MONTE CAPANNE E PROMONTORIO DELL'ENFOLA	95	66	69.5
IT6040043	MONTI AUSONI E AURUNCI	776	66	8.5
ITA020039	MONTE CANE, PIZZO SELVA A MARE, MONTE TRIGNA	69	66	95.7
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	65	77.4
ITA090029	PANTANI DELLA SICILIA SUD-ORIENTALE, MORGHELLA, DI MARZAMEMI, DI PUNTA PILIERI E	80	65	81.2
ITA020021	MONTAGNA LONGA, PIZZO MONTANELLO	69	64	92.8
IT51A0008	MONTE D'ALMA	79	62	78.5
IT51A0036	PIANURE DEL PARCO DELLA MAREMMA	61	61	100.0
IT6040015	PARCO NAZIONALE DEL CIRCEO	151	61	40.4
ITB030036	STAGNO DI CABRAS	60	60	100.0
IT6010056	SELVA DEL LAMONE E MONTI DI CASTRO	109	59	54.1
ITA020003	BOSCHI DI SAN MAURO CASTELVERDE	59	59	100.0
ITB030032	STAGNO DI CORRU S'ITTIRI	69	59	85.5
ITA020020	QUERCETI SEMPREVERDI DI GERACI SICULO E CASTELBUONO	58	58	100.0
ITA020037	MONTI BARRACÙ, CARDELIA, PIZZO CANGIALOSI E GOLE DEL TORRENTE CORLEONE	74	56	75.7
ITA030039	MONTE PELATO	55	55	100.0
IT51A0009	MONTE LEONI	74	54	73.0
IT51A0026	LAGUNA DI ORBETELLO	58	54	93.1
IT51A0016	MONTI DELL'UCCELLINA	65	53	81.5
ITA020008	ROCCA BUSAMBRA E ROCCHE DI RAO	86	53	61.6
ITB012211	ISOLA ROSSA - COSTA PARADISO	66	52	78.8
ITB023037	COSTA E ENTROTERRA DI BOSA, SUNI E MONTRESTA	126	52	41.3
ITB040027	ISOLA DI SAN PIETRO	72	52	72.2
ITA010020	ISOLA DI PANTELLERIA - AREA COSTIERA, FALESIE E BAGNO DELL'ACQUA	68	51	75.0
ITA020030	MONTE MATASSARO, MONTE GRADARA E MONTE SIGNORA	62	51	82.3
ITA030017	VALLONE LACCARETTA E URIO QUATTROCCHI	51	51	100.0
ITB034008	STAGNO DI CABRAS	50	50	100.0
ITB044003	STAGNO DI CAGLIARI	57	50	87.7
ITA050007	SUGHERETA DI NISCEMI	48	48	100.0
ITA080003	VALLATA DEL FIUME IPPARI (PINETA DI VITTORIA)	48	48	100.0
ITA060006	MONTE SAMBUGHETTI, MONTE CAMPANITO	47	47	100.0
IT51A0021	MEDIO CORSO DEL FIUME ALBEGNA	46	46	100.0
ITB040031	MONTE ARCUENTU E RIO PISCINAS	138	46	33.3

Code	Name	PA cells	PSA cells	Perc. PSA
IT9310304	ALTO IONIO COSENTINO	381	45	11.8
ITA010019	ISOLA DI PANTELLERIA: MONTAGNA GRANDE E MONTE GIBELE	45	45	100.0
ITA020031	MONTE D'INDISI, MONTAGNA DEI CAVALLI, PIZZO PONTORNO E PIAN DEL LEONE	48	45	93.8
ITA090020	MONTI CLIMITI	45	45	100.0
ITA020002	BOSCHI DI GIBILMANNA E CEFALÙ	44	44	100.0
IT9350300	COSTA VIOLA	239	43	18.0
ITA020007	BOSCHI FICUZZA E CAPPELLIERE, VALLONE CERASA, CASTAGNETI MEZZOJUSO	59	43	72.9
ITA050001	BIVIERE E MACCONI DI GELA	55	43	78.2
ITA010031	LAGHETTI DI PREOLA E GORGHI TONDI, SCIARE DI MAZARA E PANTANO LEONE	42	42	100.0
ITA020028	SERRA DEL LEONE E MONTE STAGNATARO	51	42	82.4
ITA040007	PIZZO DELLA RONDINE, BOSCO DI S. STEFANO QUISQUINA	48	42	87.5
IT6010017	SISTEMA FLUVIALE FIORA - OLPETA	57	41	71.9
IT9110012	TESTA DEL GARGANO	97	41	42.3
ITA010015	COMPLESSO MONTI DI CASTELLAMMARE DEL GOLFO (TP)	44	41	93.2
ITA020018	FOCE DEL FIUME POLLINA E MONTE TARDARA	41	41	100.0
ITA010005	LAGHETTI DI PREOLA E GORGHI TONDI E SCIARE DI MAZARA	40	40	100.0
ITA020033	MONTE SAN CALOGERO (TERMINI IMERESE)	40	40	100.0
ITB022212	SUPRAMONTE DI OLIENA, ORGOSOLO E URZULEI - SU SERCONE	281	40	14.2
ITA020026	MONTE PIZZUTA, COSTA DEL CARPINETO, MOARDA	40	39	97.5
ITA010027	ARCIPELAGO DELLE EGADI - AREA MARINA E TERRESTRE	77	38	49.4
ITA020036	MONTE TRIONA E MONTE COLOMBA	57	38	66.7
ITA060010	VALLONE ROSSOMANNO	38	38	100.0
ITA020029	MONTE ROSE E MONTE PERNICE	38	37	97.4
ITA070001	FOCE DEL FIUME SIMETO E LAGO GORNALUNGA	37	37	100.0
ITB010042	CAPO CACCIA (CON LE ISOLE FORADADA E PIANA) E PUNTA DEL GIGLIO	75	37	49.3
ITA030018	PIZZO MICHELE	36	36	100.0
ITA090016	ALTO CORSO DEL FIUME ASINARO, CAVA PIRARO E CAVA CAROSELLO	36	36	100.0
ITB040021	COSTA DI CAGLIARI	44	36	81.8
IT8030008	DORSALE DEI MONTI LATTARI	184	35	19.0
IT9150002	COSTA OTRANTO - SANTA MARIA DI LEUCA	74	35	47.3
ITA020032	BOSCHI DI GRANZA	35	35	100.0
ITA030030	ISOLA DI LIPARI	53	35	66.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITA090021	CAVA CONTESSA - CUGNO LUPO	35	35	100.0
ITB020015	AREA DEL MONTE FERRU DI TERTENIA	41	35	85.4
IT51A0019	ALTO CORSO DEL FIUME FIORA	122	34	27.9
IT9110015	DUNA E LAGO DI LESINA - FOCE DEL FORTORE	148	34	23.0
ITA060009	BOSCO DI SPERLINGA, ALTO SALSO	34	34	100.0
ITB033036	COSTA DI CUGLIERI	41	34	82.9
ITB040071	DA PISCINAS A RIU SCIVU	39	34	87.2
IT9320302	MARCHESATO E FIUME NETO	809	33	4.1
ITA010028	STAGNONE DI MARSALA E SALINE DI TRAPANI - AREA MARINA E TERRESTRE	55	33	60.0
ITA020027	MONTE IATO, KUMETA, MAGANOCE E PIZZO PARRINO	54	33	61.1
ITA020035	MONTE GENUARDO E SANTA MARIA DEL BOSCO	35	33	94.3
ITA030042	MONTI PELORITANI, DORSALE CURCURACI, ANTENNA-MARE E AREA MARINA DELLO STRETTO DI	245	33	13.5
ITB040030	CAPO PECORA	55	32	58.2
ITA030013	ROCCHE DI ALCARA LI FUSI	34	31	91.2
ITB040025	PROMONTORIO, DUNE E ZONA UMIDA DI PORTO PINO	40	31	77.5
ITA090019	CAVA CARDINALE	30	30	100.0
ITB010004	FOCI DEL COGHINAS	38	30	78.9
ITB044009	FORESTA DI MONTE ARCOSU	45	30	66.7
ITA080002	ALTO CORSO DEL FIUME IRMINO	29	29	100.0
ITA090022	BOSCO PISANO	29	29	100.0
ITB043025	STAGNI DI COLOSTRAI	36	29	80.6
IT9130004	MAR PICCOLO	39	28	71.8
ITA040005	MONTE CAMMARATA - CONTRADA SALACI	31	28	90.3
ITA090023	MONTE LAURO	28	28	100.0
IT8050048	COSTA TRA PUNTA TRESINO E LE RIPE ROSSE	54	27	50.0
ITA020040	MONTE ZIMMARA (GANGI)	27	27	100.0
ITA090002	VENDICARI	30	27	90.0
ITB010001	ISOLA ASINARA	86	27	31.4
ITB010082	ISOLA DELL’ASINARA	91	27	29.7
ITA020044	MONTE GRIFONE	35	26	74.3
ITA060005	LAGO DI ANCIPA	26	26	100.0
ITA090003	PANTANI DELLA SICILIA SUD ORIENTALE	37	26	70.3
ITB040024	ISOLA ROSSA E CAPO TEULADA	48	26	54.2
IT1323201	FINALESE - CAPO NOLI	49	25	51.0
IT6010016	MONTI DI CASTRO	25	25	100.0
ITA080009	CAVA D’ISPICA	25	25	100.0
ITA090018	FIUME TELLESIMO	25	25	100.0
ITB010043	COSTE E ISOLETTE A NORD OVEST DELLA SARDEGNA	48	25	52.1
ITB041111	MONTE LINAS - MARGANAI	300	25	8.3
IT51A0023	ISOLA DEL GIGLIO	34	24	70.6
IT8030010	FONDALI MARINI DI ISCHIA, PROCIDA E VIVARA	69	24	34.8

Code	Name	PA cells	PSA cells	Perc. PSA
IT9110009	VALLONI DI MATTINATA - MONTE SACRO	97	24	24.7
ITA090024	COZZO OGLIASTRI	24	24	100.0
ITB040022	STAGNO DI MOLENTARGIUS E TERRITORI LIMITROFI	30	24	80.0
IT9120002	MURGIA DEI TRULLI	95	23	24.2
IT9130006	PINETE DELL'ARCO IONICO	67	23	34.3
ITB034004	CORRU S'ITTIRI, STAGNO DI S. GIOVANNI E MARCEDDÌ	26	23	88.5
IT51A0011	PADULE DI DIACCIA BOTRONA	24	22	91.7
ITA010023	MONTAGNA GRANDE DI SALEMI	24	22	91.7
ITA010024	FONDALI DELL'ISOLA DI FAVIGNANA	36	22	61.1
ITA030027	ISOLA DI VULCANO	33	22	66.7
ITB010006	MONTE RUSSU	39	22	56.4
IT6030025	MACCHIA GRANDE DI PONTE GALERIA	21	21	100.0
IT9110025	MANACORE DEL GARGANO	32	21	65.6
IT9150009	LITORALE DI UGENTO	27	21	77.8
ITA010004	ISOLA DI FAVIGNANA	33	21	63.6
ITA010007	SALINE DI TRAPANI	25	21	84.0
ITA020011	ROCCHE DI CASTRONUOVO, PIZZO LUPO, GURGHI DI S. ANDREA	31	21	67.7
ITA020034	MONTE CARCACI, PIZZO COLOBRIA E AMBIENTI UMIDI	28	21	75.0
ITA040004	FOCE DEL FIUME VERDURA	28	21	75.0
ITA060003	LAGO DI POZZILLO	52	21	40.4
ITA060004	MONTE ALTESINA	23	21	91.3
ITA070015	CANALONE DEL TRIPODO	31	21	67.7
IT9110037	LAGHI DI LESINA E VARANO	212	20	9.4
ITA010010	MONTE SAN GIULIANO	20	20	100.0
ITB011155	LAGO DI BARATZ - PORTO FERRO	25	20	80.0
ITB043035	COSTA E ENTROTERRA TRA PUNTA CANNONI E PUNTA DELLE OCHE - ISOLA DI SAN PIETRO	28	20	71.4
ITB044002	SALINE DI MOLENTARGIUS	24	20	83.3
ITA020024	ROCCHE DI CIMINNA	27	19	70.4
ITA040003	FOCE DEL MAGAZZOLO, FOCE DEL PLATANI, CAPO BIANCO, TORRE SALSA	34	19	55.9
IT1331402	BEIGUA - MONTE DENTE - GARGASSA - PAVAGLIONE	220	18	8.2
IT5160006	ISOLA DI CAPRAIA	33	18	54.5
IT8030005	CORPO CENTRALE DELL'ISOLA DI ISCHIA	24	18	75.0
IT9130002	MASSERIA TORRE BIANCA	18	18	100.0
IT9150011	ALIMINI	36	18	50.0
IT9340091	ZONA COSTIERA FRA BRIATICO E NICOTERA	40	18	45.0
ITB010008	ARCIPELAGO LA MADDALENA	126	18	14.3
ITB030037	STAGNO DI SANTA GIUSTA	20	18	90.0
IT1324910	MONTE ACUTO - POGGIO GRANDE - RIO TORSERO	45	17	37.8
IT5160007	ISOLA DI CAPRAIA - AREA TERRESTRE E MARINA	32	17	53.1
IT7228221	FOCE TRIGNO - MARINA DI PETACCIATO	27	17	63.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITA030016	PIZZO DELLA BATTAGLIA	17	17	100.0
ITA030029	ISOLA DI SALINA (STAGNO DI LINGUA)	20	17	85.0
ITA070016	VALLE DEL BOVE	45	17	37.8
IT8050047	COSTA TRA MARINA DI CAMEROTA E POLICASTRO BUSSENTINO	52	16	30.8
ITA030015	VALLE DEL FIUME CARONIA, LAGO ZILIO	16	16	100.0
ITA060008	CONTRADA GIAMMAIANO	16	16	100.0
ITA090017	CAVA PALOMBIERI	16	16	100.0
ITB010003	STAGNO E GINEPRETO DI PLATAMONA	28	16	57.1
ITB032228	IS ARENAS	20	16	80.0
IT51A0010	POGGIO DI MOSCONA	15	15	100.0
IT6040010	LAGO DI FONDI	19	15	78.9
IT9110016	PINETA MARZINI	18	15	83.3
ITA020014	MONTE PELLEGRINO	15	15	100.0
ITA060011	CONTRADA CAPRARA	21	15	71.4
ITB030035	STAGNO DI SALE 'E PORCUS	15	15	100.0
IT5160013	ISOLA DI PIANOSA	21	14	66.7
IT5160016	ISOLA DI PIANOSA - AREA TERRESTRE E MARINA	22	14	63.6
IT8010015	MONTE MASSICO	56	14	25.0
IT9150027	PALUDE DEL CONTE, DUNE DI PUNTA PROSCIUTTO	14	14	100.0
IT9350158	COSTA VIOLA E MONTE S. ELIA	22	14	63.6
ITA010008	COMPLESSO MONTE BOSCO E SCORACE	14	14	100.0
ITA020006	CAPO GALLO	14	14	100.0
ITA030003	RUPI DI TAORMINA E MONTE VENERETTA	14	14	100.0
ITB013044	CAPO CACCIA	51	14	27.5
ITB020012	BERCHIDA E BIDDEROSA	37	14	37.8
ITB034007	STAGNO DI SALE E' PORCUS	14	14	100.0
ITB040019	STAGNI DI COLOSTRAI E DELLE SALINE	19	14	73.7
ITB043056	GIARA DI SIDDI	20	14	70.0
IT1323203	ROCCA DEI CORVI - MAO - MORTOU	30	13	43.3
IT1324909	TORRENTE ARROSCIA E CENTA	15	13	86.7
IT6030047	BOSCO DI FOGLINO	13	13	100.0
IT6040014	FORESTA DEMANIALE DEL CIRCEO	47	13	27.7
IT8030018	LAGO DI PATRIA	14	13	92.9
IT8050010	FASCE LITORANEE A DESTRA E A SINISTRA DEL FIUME SELE	24	13	54.2
ITA070004	TIMPA DI ACIREALE	13	13	100.0
ITA070014	MONTE BARACCA, CONTRADA GIARRITA	29	13	44.8
ITA090006	SALINE DI SIRACUSA E FIUME CIANE	13	13	100.0
ITA090015	TORRENTE SAPILLONE	13	13	100.0
ITB030034	STAGNO DI MISTRAS DI ORISTANO	25	13	52.0
IT5160014	ISOLA DI MONTECRISTO	20	12	60.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT5160017	ISOLA DI MONTECRISTO E FORMICA DI MONTECRISTO - AREA TERRESTRE E MARINA	20	12	60.0
IT6030044	MACCHIA DELLA SPADELLATA E FOSSO S. ANASTASIO	12	12	100.0
IT9110004	FORESTA UMBRA	255	12	4.7
IT9130001	TORRE COLIMENA	31	12	38.7
IT9320095	FOCE NETO	15	12	80.0
ITA010011	SISTEMA DUNALE CAPO GRANITOLA, PORTO PALO E FOCE DEL BELICE	31	12	38.7
ITA020038	SUGHERETE DI CONTRADA SERRADAINO	12	12	100.0
ITA030026	ISOLE DI STROMBOLI E STROMBOLICCHIO	19	12	63.2
ITA040010	LITORALE DI PALMA DI MONTECHIARO	19	12	63.2
ITA050009	RUPE DI MARIANOPOLI	23	12	52.2
ITA080006	CAVA RANDELLO, PASSO MARINARO	12	12	100.0
ITB010002	STAGNO DI PILO E DI CASARACCIO	28	12	42.9
ITB013019	ISOLE DEL NORD - EST TRA CAPO CERASO E STAGNO DI SAN TEODORO	67	12	17.9
ITB040017	STAGNI DI MURTAS E S'ACQUA DURCI	15	12	80.0
ITB040018	FOCE DEL FLUMENDOSA - SA PRAIA	13	12	92.3
IT1315806	MONTE NERO - MONTE BIGNONE	55	11	20.0
IT5160009	PROMONTORIO DI PIOMBINO E MONTE MASSONCELLO	16	11	68.8
IT6030053	SUGHERETA DI CASTEL DI DECIMA	11	11	100.0
IT6040017	PROMONTORIO DEL CIRCEO (QUARTO FREDDO)	14	11	78.6
IT7222217	FOCE SACCIONE - BONIFICA RAMITELLI	20	11	55.0
IT8030011	FONDALI MARINI DI PUNTA CAMPANELLA E CAPRI	69	11	15.9
IT9120011	VALLE OFANTO - LAGO DI CAPACIOTTI	192	11	5.7
IT9150015	LITORALE DI GALLIPOLI E ISOLA S. ANDREA	18	11	61.1
IT9150030	BOSCO LA LIZZA E MACCHIA DEL PAGLIARONE	11	11	100.0
IT9310043	FIUMARA AVENA	22	11	50.0
IT9320104	COLLINE DI CROTONE	12	11	91.7
ITA010002	ISOLA DI MARETTIMO	24	11	45.8
ITA050011	TORRE MANFRIA	24	11	45.8
ITA060002	LAGO DI PERGUSA	11	11	100.0
ITA060013	SERRE DI MONTE CANNARELLA	25	11	44.0
ITB013012	STAGNO DI PILO, CASARACCIO E SALINE DI STINTINO	24	11	45.8
ITB040020	ISOLA DEI CAVOLI, SERPENTARA, PUNTA MOLENTIS E CAMPULONGU	34	11	32.4
ITB042247	IS COMPINXIUS - CAMPO DUNALE DI BUGERRU - PORTIXEDDU	11	11	100.0
ITB043032	ISOLA DI SANT'ANTIOCO, CAPO SPERONE	23	11	47.8
IT5160003	TOMBOLO DI CECINA	19	10	52.6
IT5160004	PADULE DI BOLGHERI	10	10	100.0
IT51A0014	PINETA GRANDUCALE DELL'UCCELLINA	13	10	76.9
IT8050032	MONTE TRESINO E DINTORNI	22	10	45.5

Code	Name	PA cells	PSA cells	Perc. PSA
IT8050036	PARCO MARINO DI S. MARIA DI CASTELLABATE	21	10	47.6
IT9140002	LITORALE BRINDISINO	18	10	55.6
IT9310042	FIUMARA SARACENO	27	10	37.0
ITA060007	VALLONE DI PIANO DELLA CORTE	15	10	66.7
ITA060015	CONTRADA VALANGHE	39	10	25.6
ITA070018	PIANO DEI GRILLI	24	10	41.7
IT1315717	MONTE GRAMMONDO - TORRENTE BEVERA	45	9	20.0
IT1331578	BEIGUA - TURCHINO	145	9	6.2
IT1332603	PARCO DI PORTOFINO	25	9	36.0
IT6030004	VALLE DI RIO FIUME	26	9	34.6
IT6030028	CASTEL PORZIANO (QUERCETI IGROFILI)	9	9	100.0
IT8050026	MONTE LICOSA E DINTORNI	20	9	45.0
IT9150032	LE CESINE	19	9	47.4
IT9150033	SPECCHIA DELL'ALTO	14	9	64.3
IT9220055	BOSCO PANTANO DI POLICORO E COSTA IONICA FOCE SINNI	23	9	39.1
ITA010021	SALINE DI MARSALA	14	9	64.3
ITA020019	RUPI DI CATALFANO E CAPO ZAFFERANO	10	9	90.0
ITA020022	CALANCHI, LEMBI BOSCHIVI E PRATERIE DI RIENA	16	9	56.2
ITA020047	FONDALI DI ISOLA DELLE FEMMINE - CAPO GALLO	12	9	75.0
ITB030016	STAGNO DI S'ENA ARRUBIA E TERRITORI LIMITROFI	9	9	100.0
ITB042226	STAGNO DI PORTO BOTTE	18	9	50.0
ITB043028	CAPO CARBONARA E STAGNO DI NOTTERI - PUNTA MOLENTIS	20	9	45.0
IT5120016	MACCHIA LUCCHESE	10	8	80.0
IT51A0012	TOMBOLO DA CASTIGLION DELLA PESCAIA A MARINA DI GROSSETO	16	8	50.0
IT8030009	FOCE DI LICOLA	8	8	100.0
IT8050039	PINETA DI SANT'ICONIO	10	8	80.0
IT8050051	VALLONI DELLA COSTIERA AMALFITANA	15	8	53.3
IT9150006	RAUCCIO	12	8	66.7
IT9310044	FOCE DEL FIUME CRATI	10	8	80.0
IT9320106	STECCATO DI CUTRO E COSTA DEL TURCHESE	16	8	50.0
ITA010009	MONTE BONIFATO	8	8	100.0
ITA010016	MONTE COFANO E LITORALE	13	8	61.5
ITA020045	ROCCA DI SCIARA	8	8	100.0
ITA030024	ISOLA DI FILICUDI	15	8	53.3
ITA030028	ISOLA DI SALINA (MONTE FOSSA DELLE FELCI E DEI PORRI)	15	8	53.3
ITB022214	LIDO DI ORRÌ	9	8	88.9
ITB034006	STAGNO DI MISTRAS	16	8	50.0
ITB042237	MONTE SAN MAURO	14	8	57.1
ITB042241	RIU S. BARZOLU	8	8	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITB042250	DA IS ARENAS A TONNARA (MARINA DI GONNESA)	8	8	100.0
IT1315716	ROVERINO	9	7	77.8
IT1324007	MONTE CIAZZE SECCHE	9	7	77.8
IT1331718	MONTE FASCE	24	7	29.2
IT1333307	PUNTA BAFFE - PUNTA MONEGLIA - VAL PETRONIO	27	7	25.9
IT51A0013	PADULE DELLA TRAPPOLA, BOCCA D'OMBRONE	11	7	63.6
IT51A0030	LAGO ACQUATO, LAGO SAN FLORIANO	7	7	100.0
IT6010027	LITORALE TRA TARQUINIA E MONTALTO DI CASTRO	11	7	63.6
IT6010028	NECROPOLI DI TARQUINIA	7	7	100.0
IT6010039	ACROPOLI DI TARQUINIA	7	7	100.0
IT6040006	MONTI AUSONI MERIDIONALI	73	7	9.6
IT8050011	FASCIA INTERNA DI COSTA DEGLI INFRESCHI E DELLA MASSETA	23	7	30.4
IT9140001	BOSCO TRAMAZZONE	9	7	77.8
IT9150007	TORRE ULUZZO	12	7	58.3
IT9150008	MONTAGNA SPACCATA E RUPI DI SAN MAURO	9	7	77.8
IT9310051	DUNE DI CAMIGLIANO	9	7	77.8
IT9350172	FONDALI DA PUNTA PEZZO A CAPO DELL'ARMI	22	7	31.8
ITA010006	PALUDI DI CAPO FETO E MARGI SPANÒ	15	7	46.7
ITA020009	CALA ROSSA E CAPO RAMA	13	7	53.8
ITA020043	MONTE ROSAMARINA E COZZO FAMÒ	7	7	100.0
ITA020046	FONDALI DELL'ISOLA DI USTICA	18	7	38.9
ITA030004	BACINO DEL TORRENTE LETOJANNI	25	7	28.0
ITA030022	LECCETA DI S. FRATELLO	7	7	100.0
ITA090008	CAPO MURRO DI PORCO, PENISOLA DELLA MADDALENA E GROTTA PELLEGRINO	9	7	77.8
ITA090027	FONDALI DI VENDICARI	10	7	70.0
ITB020013	PALUDE DI OSALLA	23	7	30.4
ITB032219	SASSU - CIRRAS	7	7	100.0
ITB032229	IS ARENAS S'ACQUA E S'OLLASTU	7	7	100.0
ITB042234	MONTE MANNU - MONTE LADU (COLLINE DI MONTE MANNU E MONTE LADU)	7	7	100.0
IT1345101	PIANA DEL MAGRA	17	6	35.3
IT51A0033	LAGO DI BURANO	12	6	50.0
IT6040016	PROMONTORIO DEL CIRCEO (QUARTO CALDO)	12	6	50.0
IT8010021	PINETA DI PATRIA	11	6	54.5
IT8010027	FIUMI VOLTURNO E CALORE BENEVENTANO	219	6	2.7
IT8010029	FIUME GARIGLIANO	46	6	13.0
IT8030006	COSTIERA AMALFITANA TRA NERANO E POSITANO	26	6	23.1
IT8030015	LAGO DEL FUSARO	6	6	100.0
IT9210160	ISOLA DI S. IANNI E COSTA PROSPICIENTE	9	6	66.7
ITA010001	ISOLE DELLO STAGNONE DI MARSALA	19	6	31.6
ITA010013	BOSCO DI CALATAFIMI	6	6	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITA010018	FOCE DEL TORRENTE CALATUBO E DUNE	6	6	100.0
ITA010025	FONDALI DEL GOLFO DI CUSTONACI	11	6	54.5
ITA020010	ISOLA DI USTICA	14	6	42.9
ITA020013	LAGO DI PIANA DEGLI ALBANESI	13	6	46.2
ITA020015	COMPLESSO CALANCHIVO DI CASTELLANA SICULA	6	6	100.0
ITA020041	MONTE SAN CALOGERO (GANGI)	6	6	100.0
ITA030002	TORRENTE FIUMETTO E PIZZO D'UNCINA	25	6	24.0
ITA030012	LAGUNA DI OLIVERI - TINDARI	9	6	66.7
ITA050010	PIZZO MUCULUFA	17	6	35.3
ITA070023	MONTE MINARDO	10	6	60.0
ITA070024	MONTE ARSO	6	6	100.0
ITA080007	SPIAGGIA MAGANUCO	6	6	100.0
ITA090004	PANTANO MORGHELLA	6	6	100.0
ITA090026	FONDALI DI BRUCOLI - AGNONE	12	6	50.0
ITB034001	STAGNO DI S'ENA ARRUBIA	6	6	100.0
ITB042220	SERRA IS TRES PORTUS (SANT'ANTIOCO)	7	6	85.7
IT1315720	FIUME ROIA	10	5	50.0
IT1324011	MONTE RAVINET - ROCCA BARBENA	41	5	12.2
IT1332622	RIO TUIA - MONTALLEGRO	12	5	41.7
IT1344210	PUNTA MESCO	16	5	31.2
IT5120017	LAGO E PADULE DI MASSACCIUCCOLI	33	5	15.2
IT51A0005	LAGO DELL'ACCESA	20	5	25.0
IT51A0006	PADULE DI SCARLINO	5	5	100.0
IT51A0028	DUNA DI FENIGLIA	13	5	38.5
IT6010018	LITORALE A NORD OVEST DELLE FOCI DEL FIORA	12	5	41.7
IT6030023	MACCHIA GRANDE DI FOCENE E MACCHIA DELLO STAGNETO	7	5	71.4
IT6030027	CASTEL PORZIANO (FASCIA COSTIERA)	14	5	35.7
IT6040012	LAGHI FOGLIANO, MONACI, CAPROLACE E PANTANI DELL'INFERNO	34	5	14.7
IT6040013	LAGO DI SABAUDIA	16	5	31.2
IT6040024	RIO S. CROCE	5	5	100.0
IT8030019	MONTE BARBARO E CRATERE DI CAMPIGLIONE	10	5	50.0
IT8030038	CORPO CENTRALE E RUPI COSTIERE OCCIDENTALI DELL'ISOLA DI CAPRI	13	5	38.5
IT9140005	TORRE GUACETO E MACCHIA S. GIOVANNI	11	5	45.5
IT9150014	LE CESINE	14	5	35.7
IT9210155	MARINA DI CASTROCUCCO	13	5	38.5
IT9310052	CASONI DI SIBARI	9	5	55.6
ITA010003	ISOLA DI LEVANZO	12	5	41.7
ITA010026	FONDALI DELL'ISOLA DELLO STAGNONE DI MARSALA	16	5	31.2
ITA030001	STRETTA DI LONGI	19	5	26.3
ITA030011	DORSALE CURCURACI, ANTENNAMARE	153	5	3.3

Code	Name	PA cells	PSA cells	Perc. PSA
ITA030033	CAPO CALAVÀ	6	5	83.3
ITA040001	ISOLA DI LINOSA	10	5	50.0
ITA040013	ARCIPELAGO DELLE PELAGIE - AREA MARINA E TERRESTRE	50	5	10.0
ITA050008	RUPE DI FALCONARA	5	5	100.0
ITA060001	LAGO OGLIASTRO	22	5	22.7
ITA070017	SCIARE DI ROCCAZZO DELLA BANDIERA	39	5	12.8
ITA070021	BOSCO DI S. MARIA LA STELLA	5	5	100.0
ITA070028	FONDALI DI ACICASTELLO (ISOLA LACHEA - CICLOPI)	7	5	71.4
ITB010011	STAGNO DI SAN TEODORO	15	5	33.3
ITB030038	STAGNO DI PUTZU IDU (SALINA MANNA E PAULI MARIGOSA)	10	5	50.0
ITB030080	ISOLA DI MAL DI VENTRE E CATALANO	18	5	27.8
ITB042218	STAGNO DI PISCINNÌ	8	5	62.5
IT1315719	TORRENTE NERVIA	5	4	80.0
IT1343412	DEIVA - BRACCO - PIETRA DI VASCA - MOLA	33	4	12.1
IT1345005	PORTOVENERE - RIOMAGGIORE - S. BENEDETTO	50	4	8.0
IT5160010	PADULE ORTI - BOTTAGONE	4	4	100.0
IT6030026	LAGO DI TRAIANO	4	4	100.0
IT6040018	DUNE DEL CIRCEO	33	4	12.1
IT6040027	MONTE REDENTORE (VERSANTE SUD)	10	4	40.0
IT8010020	PINETA DI CASTELVOLTURNO	4	4	100.0
IT8010028	FOCE VOLTURNO - VARICONI	8	4	50.0
IT8050012	FIUME ALENTO	95	4	4.2
IT8050038	PARETI ROCCIOSE DI CALA DEL CEFALO	6	4	66.7
IT9110001	ISOLA E LAGO DI VARANO	104	4	3.8
IT9140009	FOCE CANALE GIANCOLA	5	4	80.0
IT9150021	BOSCO LE CHIUSE	4	4	100.0
IT9150029	BOSCO DI CERVALORA	4	4	100.0
IT9210015	ACQUAFREDDA DI MARATEA	11	4	36.4
IT9220080	COSTA IONICA FOCE AGRI	17	4	23.5
IT9220085	COSTA IONICA FOCE BASENTO	13	4	30.8
IT9220090	COSTA IONICA FOCE BRADANO	14	4	28.6
IT9320102	DUNE DI SOVERETO	6	4	66.7
IT9330098	OASI DI SCOLACIUM	4	4	100.0
IT9350160	SPIAGGIA DI BRANCALEONE	5	4	80.0
IT9350177	MONTE SCRISI	8	4	50.0
ITA030041	FONDALI DELL'ISOLA DI SALINA	5	4	80.0
ITA060014	MONTE CHIAPPARO	28	4	14.3
ITA070011	POGGIO S. MARIA	14	4	28.6
ITA080004	PUNTA BRACCETTO, CONTRADA CAMMARANA	18	4	22.2
ITA090010	ISOLA CORRENTI, PANTANI DI PUNTA PILIERI, CHIUSA DELL'ALGA E PARRINO	8	4	50.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITB040028	PUNTA S'ALIGA	11	4	36.4
ITB042223	STAGNO DI SANTA CATERINA	11	4	36.4
ITB042225	IS PRUINIS	6	4	66.7
IT1315922	POMPEIANA	6	3	50.0
IT1324896	LERRONE - VALLONI	5	3	60.0
IT1333308	PUNTA MANARA	6	3	50.0
IT1343419	MONTE SERRO	8	3	37.5
IT1343502	PARCO DELLA MAGRA - VARA	93	3	3.2
IT1344270	FONDALI PUNTA MESCO - RIO MAGGIORE	13	3	23.1
IT1344323	COSTA RIOMAGGIORE - MONTEROSSO	12	3	25.0
IT51A0004	POGGIO TRE CANCELLI	8	3	37.5
IT51A0015	DUNE COSTIERE DEL PARCO DELL'UCCELLINA	10	3	30.0
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0031	LAGO DI BURANO	7	3	42.9
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6010019	PIAN DEI CANGANI	4	3	75.0
IT6010026	SALINE DI TARQUINIA	6	3	50.0
IT6030016	ANTICA LAVINIUM - PRATICA DI MARE	3	3	100.0
IT6030019	MACCHIATONDA	6	3	50.0
IT6030045	LIDO DEI GIGLI	6	3	50.0
IT6040025	FIUME GARIGLIANO (TRATTO TERMINALE)	4	3	75.0
IT7222216	FOCE BIFERNO - LITORALE DI CAMPOMARINO	19	3	15.8
IT7228230	LAGO DI GUARDIALFIERA - FOCE FIUME BIFERNO	401	3	0.7
IT8010019	PINETA DELLA FOCE DEL GARIGLIANO	7	3	42.9
IT8030007	CRATERE DI ASTRONI	8	3	37.5
IT8030026	RUPI COSTIERE DELL'ISOLA DI ISCHIA	22	3	13.6
IT8050040	RUPI COSTIERE DELLA COSTA DEGLI INFRESCHI E DELLA MASSETA	15	3	20.0
IT9140003	STAGNI E SALINE DI PUNTA DELLA CONTESSA	10	3	30.0
IT9140006	BOSCO DI SANTA TERESA	4	3	75.0
IT9140008	TORRE GUACETO	8	3	37.5
IT9150013	PALUDE DEL CAPITANO	4	3	75.0
IT9150024	TORRE INSERRAGLIO	5	3	60.0
IT9150025	TORRE VENERI	12	3	25.0
IT9310045	MACCHIA DELLA BURA	3	3	100.0
IT9330108	DUNE DI GUARDAVALLE	3	3	100.0
IT9330184	SCOGLIERA DI STALETTI	3	3	100.0
IT9350144	CALANCHI DI PALIZZI MARINA	5	3	60.0
IT9350148	FIUMARA DI PALIZZI	7	3	42.9
ITA010022	COMPLESSO MONTI DI SANTA NINFA - GIBELLINA E GROTTA DI SANTA NINFA	14	3	21.4
ITA020001	ROCCA DI CEFALÙ	3	3	100.0
ITA020012	VALLE DEL FIUME ORETO	15	3	20.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITA030023	ISOLA DI ALICUDI	8	3	37.5
ITA040009	MONTE SAN CALOGERO (SCIACCA)	3	3	100.0
ITA050003	LAGO SOPRANO	4	3	75.0
ITA050006	MONTE CONCA	9	3	33.3
ITA070002	RISERVA NATURALE FIUME FIUMEFREDDO	3	3	100.0
ITA070003	LA GURNA	4	3	75.0
ITA070008	COMPLESSO IMMACOLATELLE, MICIO CONTI, BOSCHI LIMITROFI	3	3	100.0
ITA070013	PINETA DI LINGUAGLOSSA	14	3	21.4
ITA080001	FOCE DEL FIUME IRMINO	6	3	50.0
ITA090011	GROTTA MONELLO	3	3	100.0
ITA090012	GROTTA PALOMBARA	3	3	100.0
ITA090014	SALINE DI AUGUSTA	3	3	100.0
ITB042208	TRA POGGIO LA SALINA E PUNTA MAGGIORE	3	3	100.0
ITB042210	PUNTA GIUNCHERA	3	3	100.0
IT1325624	CAPO MELE	7	2	28.6
IT1332614	PINETA - LECCETA DI CHIAVARI	5	2	40.0
IT1333316	ROCCHE DI SANT'ANNA - VALLE DEL FICO	6	2	33.3
IT1344216	COSTA DI BONASSOLA - FRAMURA	7	2	28.6
IT1345109	MONTEMARCELLO	25	2	8.0
IT5160002	ISOLA DI GORGONA	6	2	33.3
IT5160015	ISOLA DI GORGONA - AREA TERRESTRE E MARINA	7	2	28.6
IT5170001	DUNE LITORANEE DI TORRE DEL LAGO	6	2	33.3
IT51A0007	PUNTA ALA E ISOLOTTO DELLO SPARVIERO	11	2	18.2
IT51A0032	DUNA DEL LAGO DI BURANO	7	2	28.6
IT6010040	MONTEROZZI	2	2	100.0
IT6030020	TORRE FLAVIA	3	2	66.7
IT6030046	TOR CALDARA (ZONA SOLFATARE E FOSSI)	2	2	100.0
IT6030048	LITORALE DI TORRE ASTURA	15	2	13.3
IT6030049	ZONE UMIDE A OVEST DEL FIUME ASTURA	3	2	66.7
IT6040007	MONTE LEANO	12	2	16.7
IT6040011	LAGO LUNGO	4	2	50.0
IT6040022	COSTA ROCCIOSA TRA SPERLONGA E GAETA	19	2	10.5
IT7140109	MARINA DI VASTO	4	2	50.0
IT8010018	VARICONI	6	2	33.3
IT8030001	AREE UMIDE DEL CRATERE DI AGNANO	2	2	100.0
IT8030013	ISOLOTTO DI S. MARTINO E DINTORNI	2	2	100.0
IT8030014	LAGO D'AVERNO	4	2	50.0
IT8030020	MONTE NUOVO	4	2	50.0
IT8030022	PINETE DELL'ISOLA DI ISCHIA	3	2	66.7
IT8030024	PUNTA CAMPANELLA	10	2	20.0
IT8030034	STAZIONE DI CYPERUS POLYSTACHYUS DI ISCHIA	2	2	100.0
IT8050013	FIUME MINGARDO	64	2	3.1

Code	Name	PA cells	PSA cells	Perc. PSA
IT8050037	PARCO MARINO DI PUNTA DEGLI INFRESCHI	24	2	8.3
IT8050041	SCOGLIO DEL MINGARDO E SPIAGGIA DI CALA DEL CEFALO	5	2	40.0
IT8050045	SORGENTI DEL VALLONE DELLE FERRIERE DI AMALFI	10	2	20.0
IT8050054	COSTIERA AMALFITANA TRA MAIORI E IL TORRENTE BONEA	17	2	11.8
IT9110002	VALLE FORTORE, LAGO DI OCCHITO	178	2	1.1
IT9150001	BOSCO GUARINI	2	2	100.0
IT9150003	AQUATINA DI FRIGOLE	7	2	28.6
IT9150028	PORTO CESAREO	11	2	18.2
IT9150031	MASSERIA ZANZARA	5	2	40.0
IT9310025	VALLE DEL FIUME LAO	53	2	3.8
IT9320097	FONDALI DA CROTONE A LE CASTELLA	5	2	40.0
IT9320100	DUNE DI MARINELLA	2	2	100.0
IT9320101	CAPO COLONNE	3	2	66.7
IT9320185	FONDALI DI STALETTI	2	2	100.0
IT9330087	LAGO LA VOTA	8	2	25.0
IT9330107	DUNE DI ISCA	3	2	66.7
IT9350132	FIUMARA DI MELITO	8	2	25.0
IT9350142	CAPO SPARTIVENTO	4	2	50.0
IT9350145	FIUMARA AMENDOLEA (INCLUSO ROGHUDI, CHORIO E ROTA GRECO)	25	2	8.0
IT9350146	FIUMARA BUONAMICO	30	2	6.7
IT9350147	FIUMARA LAVERDE	19	2	10.5
ITA030031	ISOLA BELLA, CAPO TAORMINA E CAPO S. ANDREA	2	2	100.0
ITA030036	RISERVA NATURALE DEL FIUME ALCANTARA	42	2	4.8
ITA030040	FONDALI DI TAORMINA - ISOLA BELLA	3	2	66.7
ITA040012	FONDALI DI CAPO SAN MARCO - SCIACCA	11	2	18.2
ITA050004	MONTE CAPODARSO E VALLE DEL FIUME IMERA MERIDIONALE	38	2	5.3
ITA070022	BOSCO DI LINERA	2	2	100.0
ITA080008	CONTRADA RELIGIONE	2	2	100.0
ITA090005	PANTANO DI MARZAMEMI	2	2	100.0
ITA090013	SALINE DI PRIOLO	3	2	66.7
ITB020040	VALLE DEL TEMO	43	2	4.7
ITB042216	SA TANCA E SA MURA - FOXI DURCI	2	2	100.0
IT1315715	CASTEL D'APPIO	1	1	100.0
IT1316001	CAPO BERTA	4	1	25.0
IT1316118	CAPO MORTOLA	3	1	33.3
IT1323202	ISOLA BERGEGGI - PUNTA PREDANI	1	1	100.0
IT1323271	FONDALI NOLI - BERGEGGI	1	1	100.0
IT1324172	FONDALI FINALE LIGURE	2	1	50.0
IT1332575	FONDALI NERVI - SORI	1	1	100.0

Code	Name	PA cells	PSA cells	Perc. PSA
IT1332674	FONDALI MONTE PORTOFINO	14	1	7.1
IT1332717	FOCE E MEDIO CORSO DEL FIUME ENTELLA	8	1	12.5
IT1343415	GUAITAROLA	11	1	9.1
IT1345104	ISOLA PALMARIA	7	1	14.3
IT5110022	LAGO DI PORTA	4	1	25.0
IT5160008	MONTE CALVI DI CAMPIGLIA	21	1	4.8
IT6010013	SELVA DEL LAMONE	46	1	2.2
IT6010014	IL CROSTOLETTO	2	1	50.0
IT6010015	VALLEROSA	1	1	100.0
IT6030022	BOSCO DI PALO LAZIALE	5	1	20.0
IT6030024	ISOLA SACRA	3	1	33.3
IT6040009	MONTE S. ANGELO	4	1	25.0
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
IT6040023	PROMONTORIO GIANOLA E MONTE DI SCAURI	7	1	14.3
IT8030003	COLLINA DEI CAMALDOLI	6	1	16.7
IT8030017	LAGO DI MISENO	4	1	25.0
IT8030032	STAZIONI DI CYANIDIUM CALDARIUM DI POZZUOLI	1	1	100.0
IT8030036	VESUVIO	54	1	1.9
IT8030037	VESUVIO E MONTE SOMMA	84	1	1.2
IT9120006	LAGHI DI CONVERSANO	20	1	5.0
IT9130003	DUNA DI CAMPOMARINO	17	1	5.9
IT9150004	TORRE DELL'ORSO	4	1	25.0
IT9150005	BOSCHETTO DI TRICASE	1	1	100.0
IT9150016	BOSCO DI OTRANTO	1	1	100.0
IT9150022	PALUDE DEI TAMARI	1	1	100.0
IT9210150	MONTE COCCOVELLO - MONTE CRIVO - MONTE CRIVE	47	1	2.1
IT9220095	COSTA IONICA FOCE CAVONE	14	1	7.1
IT9310038	SCOGLIERA DEI RIZZI	1	1	100.0
IT9310047	FIUMARA TRIONTO	42	1	2.4
IT9330089	DUNE DELL'ANGITOLA	15	1	6.7
IT9330105	FOCE DEL CROCCHIO - CROPANI	4	1	25.0
IT9340090	FIUMARA DI BRATTIRÒ (VALLE RUFA)	25	1	4.0
IT9350136	VALLATA DELLO STILARO	24	1	4.2
IT9350138	CALANCHI DI MARO SIMONE	4	1	25.0
IT9350141	CAPO S. GIOVANNI	2	1	50.0
IT9350171	SPIAGGIA DI PILATI	1	1	100.0
IT9350183	SPIAGGIA DI CATONA	2	1	50.0
ITA030008	CAPO PELORO - LAGHI DI GANZIRRI	5	1	20.0
ITA030025	ISOLA DI PANAREA E SCOGLI VICINIORI	7	1	14.3
ITA070006	ISOLE DEI CICLOPI	2	1	50.0
ITA070012	PINETA DI ADRANO E BIANCAVILLA	34	1	2.9
ITA070026	FORRE LAVICHE DEL FIUME SIMETO	43	1	2.3

Code	Name	PA cells	PSA cells	Perc. PSA
ITA090028	FONDALI DELL'ISOLA DI CAPO PASSERO	4	1	25.0
ITB010007	CAPO TESTA	12	1	8.3
ITB010009	CAPO FIGARI E ISOLA FIGAROLO	13	1	7.7
ITB010010	ISOLE TAVOLARA, MOLARA E MOLAROTTO	50	1	2.0
ITB013018	CAPO FIGARI, CALA SABINA, PUNTA CANIGIONE E ISOLA FIGAROLO	20	1	5.0
ITB030033	STAGNO DI PAULI MAIORI DI ORISTANO	11	1	9.1
ITB032239	SAN GIOVANNI DI SINIS	1	1	100.0
ITB034005	STAGNO DI PAULI MAJORI	8	1	12.5
ITB042209	A NORD DI SA SALINA (CALASETTA)	1	1	100.0
ITB042230	PORTO CAMPANA	5	1	20.0
ITB042233	PUNTA DI SANTA GIUSTA (COSTA REI)	1	1	100.0
ITB042236	COSTA REI	1	1	100.0
	ITALY TOTAL:	28119	13630	48.5

PORTUGAL				
PTCON0012	COSTA SUDOESTE	1181	476	40.3
PTZPE0015	COSTA SUDOESTE	631	422	66.9
PTCON0011	ESTUÁRIO DO SADO	347	181	52.2
PTCON0013	RIA FORMOSA/CASTRO MARIM	249	167	67.1
PTZPE0011	ESTUÁRIO DO SADO	268	160	59.7
PTCON0034	COMPORTA/GALÉ	415	146	35.2
PTZPE0017	RIA FORMOSA	208	143	68.8
PTCON0010	ARRÁBIDA/ESPICHEL	199	92	46.2
PTZPE0010	ESTUÁRIO DO TEJO	395	54	13.7
PTCON0009	ESTUÁRIO DO TEJO	385	48	12.5
PTZPE0004	RIA DE AVEIRO	425	38	8.9
PTZPE0018	SAPAIS DE CASTRO MARIM	34	27	79.4
PTCON0008	SINTRA/CASCAIS	174	20	11.5
PTCON0055	DUNAS DE MIRA, GÂNDARA E GAFANHAS	262	20	7.6
PTZPE0013	LAGOA DE SANTO ANDRÉ	25	20	80.0
PTCON0057	CALDEIRÃO	578	18	3.1
PTCON0058	RIA DE ALVOR	26	17	65.4
PTCON0056	PENICHE / STª CRUZ	91	16	17.6
PTCON0017	LITORAL NORTE	71	10	14.1
PTZPE0050	CABO ESPICHEL	21	10	47.6
PTCON0054	FERNÃO FERRO / LAGOA DE ALBUFEIRA	63	9	14.3
PTZPE0012	AÇUDE DA MURTA	12	8	66.7
PTCON0050	CERRO DA CABEÇA	11	6	54.5
PTCON0018	BARRINHA DE ESMORIZ	10	5	50.0
PTZPE0014	LAGOA DA SANCHA	5	5	100.0
PTCON0052	ARADE / ODELOUCA	52	3	5.8
PTCON0037	MONCHIQUE	878	2	0.2

Code	Name	PA cells	PSA cells	Perc. PSA
PTCON0038	RIBEIRA DE QUARTEIRA	13	2	15.4
	PORTUGAL TOTAL:	7029	2125	30.2
	OVERALL NATURA 2000 TOTAL:	119894	66296	55.3

Table C.11: *Euphorbia squamigera* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES614000	SIERRA NEVADA	1925	1925	100.0	1925	100.0
ES000038	SIERRA DE ALCARAZ Y SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	2227	1380	62.0	1380	62.0
ES421000	SIERRA DE ALCARAZ Y SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	2213	1367	61.8	1367	61.8
ES000003	SIERRAS DE CAZORLA, SEGURA Y LAS VILLAS	2294	1205	52.5	1107	48.3
ES614000	SIERRA DE BAZA	608	608	100.0	608	100.0
ES611000	SIERRAS DE GADOR Y ENIX	598	598	100.0	590	98.7
ES614000	SIERRAS DEL NORDESTE	572	572	100.0	569	99.5
ES000045	MUNTANYES DE LA MARINA	557	557	100.0	557	100.0
ES617000	SIERRAS DE TEJEDA, ALMIJARA Y ALHAMA	480	480	100.0	478	99.6
ES000004	CABO DE GATA-NIJAR	477	477	100.0	416	87.2
ES611000	SIERRA DE CABRERA-BEDAR	413	413	100.0	407	98.5
ES000026	SIERRA DEL MOLINO, EMBALSE DEL QUIPAR Y LLANOS DEL CAGITAN	340	340	100.0	340	100.0
ES000026	SIERRAS DEL GIGANTE-PERYCAI, LOMAS DEL BUITRE-RIO LUCHENA Y SIERRA DE LA TORRECI	332	332	100.0	332	100.0
ES000026	SIERRA DE ALMENARA, MORERAS Y CABO COPE	327	327	100.0	327	100.0
ES611000	RAMBLAS DE GERGAL, TABERNAS Y SUR DE SIERRA ALHAMILLA	324	324	100.0	322	99.4
ES611000	SIERRA MARIA - LOS VELEZ	295	295	100.0	295	100.0
ES000026	SIERRA DE BURETE, LAVIA Y CAMBRÓN	288	288	100.0	288	100.0
ES000047	SERRES DE MARIOLA I EL CARRASCAL DE LA FONT ROJA	278	278	100.0	278	100.0
ES620003	SIERRA DE LA ALMENARA	273	273	100.0	273	100.0
ES000045	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	260	260	100.0	260	100.0
ES000026	SIERRA DE MORATALLA	258	258	100.0	258	100.0
ES614000	SIERRA DE ARANA	256	256	100.0	256	100.0
ES614000	SIERRA DE LOJA	330	255	77.3	255	77.3
ES000021	SERRES DE MARIOLA I EL CARRASCAR DE LA FONT ROJA	246	246	100.0	246	100.0
ES000021	SIERRA DE MARTÉS-MUELA DE CORTES	1554	244	15.7	244	15.7
ES521301	AITANA, SERRELLA I PUIGCAMPANA	239	239	100.0	239	100.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES000017	SIERRA ESPUÑA	223	223	100.0	223	100.0
ES521304	VALLS DE LA MARINA	212	212	100.0	212	100.0
ES523304	SERRA D'ENGUERA	211	211	100.0	211	100.0
ES620000	SIERRAS Y VEGA ALTA DEL SEGURA Y RÍOS ALHÁRABE Y MORATALLA	211	211	100.0	211	100.0
ES000015	AREA ESTEPARIA DEL ESTE DE ALBACETE	378	198	52.4	198	52.4
ES000026	MONTE EL VALLE Y SIERRAS DE ALTAHONA Y ESCALONA	196	196	100.0	196	100.0
ES521200	MAIGMÓ I SERRES DE LA FOIA DE CASTALLA	191	191	100.0	191	100.0
ES614000	SIERRA DE CASTRIL	169	169	100.0	168	99.4
ES620000	CARRASCOY Y EL VALLE	168	168	100.0	168	100.0
ES611000	SIERRA DEL OSO	166	166	100.0	166	100.0
ES614000	SIERRA DE HUETOR	158	158	100.0	158	100.0
ES000004	DESIERTO DE TABERNAS	152	152	100.0	152	100.0
ES620001	SIERRA DE LA MUELA	152	152	100.0	152	100.0
ES000045	MONTDÚVER-MARJAL DE LA SAFOR	149	149	100.0	149	100.0
ES000046	SERRES DEL SUD D'ALACANT	142	142	100.0	142	100.0
ES000026	SIERRA DE LA MUELA Y CABO TIÑOSO	147	147	100.0	136	92.5
ES000046	SIERRA ESCALONA Y DEHESA DE CAMPOAMOR	136	136	100.0	136	100.0
ES521305	ELS ALFORINS	128	128	100.0	128	100.0
ES614000	SIERRAS DEL CAMPANARIO Y LAS CABRAS	136	136	100.0	128	94.1
ES620002	SIERRA DE RICOTE-LA NAVELA	127	127	100.0	127	100.0
ES523301	SERRES DEL MONTDÚVER I MARXUQUERA	122	122	100.0	122	100.0
ES000025	SIERRAS DE RICOTE Y LA NAVELA	121	121	100.0	121	100.0
ES620000	SIERRA DE LA PILA	119	119	100.0	119	100.0
ES000045	SIERRA DE SALINAS	117	117	100.0	117	100.0
ES000007	COSTA BRAVA DE MALLORCA	143	134	93.7	115	80.4
ES521303	SIERRA DE SALINAS	115	115	100.0	115	100.0
ES000004	SIERRA ALHAMILLA	111	111	100.0	111	100.0
ES000017	SIERRA DE LA PILA	109	109	100.0	109	100.0
ES620001	SIERRA DE VILLAFUERTE	109	109	100.0	109	100.0
ES620004	RÍO MULA Y PLIEGO	104	104	100.0	104	100.0
ES620001	LA MUELA Y CABO TIÑOSO	110	110	100.0	103	93.6
ES611001	SIERRA DEL ALTO DE ALMAGRO	94	94	100.0	94	100.0
ES000045	ELS ALFORINS	92	92	100.0	92	100.0
ES611001	CALARES DE SIERRA DE LOS FILABRES	91	91	100.0	91	100.0
ES620000	SIERRA DE EL CARCHE	86	86	100.0	86	100.0
ES611001	SIERRAS ALMAGRERA, DE LOS PINOS Y EL AGUILON	87	87	100.0	84	96.6
ES000044	D'ALFABIA A BINIARROI	112	112	100.0	83	74.1
ES523301	SERRA DE CORBERA	83	83	100.0	83	100.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES521302	SERRA DE CREVILLENT	78	78	100.0	78	100.0
ES521201	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	77	100.0	77	100.0
ES620003	LOMAS DEL BUITRE Y RÍO LUCHENA	77	77	100.0	77	100.0
ES000026	SALADARES DEL GUADALENTIN	76	76	100.0	76	100.0
ES000046	CABEÇO D'OR I LA GRANA	74	74	100.0	74	100.0
ES620003	SIERRA DEL BUEY	74	74	100.0	74	100.0
ES620002	SIERRA DE LA TERCIA	73	73	100.0	73	100.0
ES620001	SALADARES DEL GUADALENTÍN	70	70	100.0	70	100.0
ES620004	RÍO QUÍPAR	69	69	100.0	69	100.0
ES000019	ESTEPAS DE YECLA	67	67	100.0	67	100.0
ES620001	SIERRA DEL GAVILÁN	66	66	100.0	66	100.0
ES620002	CASA ALTA-LAS SALINAS	63	63	100.0	63	100.0
ES620002	SIERRA DEL GIGANTE	61	61	100.0	61	100.0
ES000005	LLACUNES DE LA MATA I TORREVIEJA.	60	60	100.0	60	100.0
ES620001	REVOLCADORES	60	60	100.0	60	100.0
ES000045	MECA-MUGRÓN-SAN BENITO	98	59	60.2	59	60.2
ES523304	MUELA DE CORTES Y EL CAROCHE	690	58	8.4	58	8.4
ES521302	SERRES DEL FERRER I BÈRNIA	57	57	100.0	57	100.0
ES620004	SIERRA DE LA TORRECILLA	57	57	100.0	57	100.0
ES000046	RIU MONTNEGRE	56	56	100.0	56	100.0
ES617001	SIERRA DE CAMAROLOS	132	51	38.6	51	38.6
ES620001	SIERRA DE LAS MORERAS	50	50	100.0	50	100.0
ES523304	SERRA DE LA SAFOR	49	49	100.0	49	100.0
ES000045	MORATILLAS-ALMELA	48	48	100.0	48	100.0
ES523200	RIU XÚQUER	74	48	64.9	48	64.9
ES000008	SES SALINES D'EIVISSA I FORMENTERA	76	76	100.0	47	61.8
ES421000	LAGUNAS SALADAS DE PETROLA Y SALOBREJO Y COMPLEJO LAGUNAR DE CORRAL RUBIO	53	47	88.7	47	88.7
ES531003	CAP LLENTRISCA-SA TALAIA	50	50	100.0	46	92.0
ES620000	CALBLANQUE, MONTE DE LAS CENIZAS Y PEÑA DEL ÁGUILA	52	52	100.0	45	86.5
ES620002	SIERRA DE LAVIA	44	44	100.0	44	100.0
ES611000	KARST EN YESOS DE SORBAS	43	43	100.0	43	100.0
ES614001	BARRANCOS DEL RIO DE AGUAS BLANCAS	42	42	100.0	42	100.0
ES000012	SALINAS DE SANTA POLA.	44	44	100.0	41	93.2
ES000005	EL FONDO D'ELX-CREVILLENT	39	39	100.0	39	100.0
ES000019	HUMEDAL DE AJAUQUE Y RAMBLA SALADA	39	39	100.0	39	100.0
ES620004	SIERRA DE ENMEDIO	39	39	100.0	39	100.0
ES620002	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	70	100.0	38	54.3

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES000026	MAR MENOR	67	67	100.0	37	55.2
ES000045	MONTGÓ-CAP DE SANT ANTONI	40	40	100.0	37	92.5
ES421001	SALADARES DE CORDOVILLA Y AGRAMON Y LAGUNA DE ALBORAJ	37	37	100.0	37	100.0
ES521100	MONTGÓ	40	40	100.0	37	92.5
ES531002	CIMALS DE LA SERRA	135	135	100.0	37	27.4
ES531000	ES GALATZÓ-S'ESCLOP	36	36	100.0	36	100.0
ES617001	SIERRA BLANCA	87	40	46.0	36	41.4
ES620003	CABEZO DE LA JARA Y RAMBLA DE NOGALTE	36	36	100.0	36	100.0
ES521302	SIERRA DE ORIHUELA	35	35	100.0	35	100.0
ES531007	PUIG DE NA BAUÇÀ	34	34	100.0	34	100.0
ES000025	SIERRA DE MOJANTES	33	33	100.0	33	100.0
ES531010	ES AMUNTS D'EIVISSA	36	36	100.0	33	91.7
ES620000	HUMEDAL DEL AJAUQUE Y RAMBLA SALADA	33	33	100.0	33	100.0
ES620000	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	40	100.0	32	80.0
ES000044	DES TEIX AL PUIG DE SES FITES	32	32	100.0	30	93.8
ES000033	ESTRECHO	160	70	43.8	29	18.1
ES523303	SIERRA DEL MUGRÓN	29	29	100.0	29	100.0
ES620003	SIERRA DEL SERRAL	28	28	100.0	28	100.0
ES521200	RIU GORGOS	27	27	100.0	27	100.0
ES523200	CURS MITJÀ DEL RIU ALBAIDA	27	27	100.0	27	100.0
ES620002	RÍO CHÍCAMO	27	27	100.0	27	100.0
ES531009	MUNTANYES DE POLLENÇA	54	54	100.0	26	48.1
ES531003	SERRA GROSSA	25	25	100.0	25	100.0
ES531011	NORD DE SANT JOAN	26	26	100.0	25	96.2
ES000014	MARJAL DE PEGO-OLIVA.	24	24	100.0	24	100.0
ES523303	MARJAL DE LA SAFOR	24	24	100.0	24	100.0
ES620000	SIERRA SALINAS	24	24	100.0	24	100.0
ES421001	SIERRA DE ABENUJ	23	23	100.0	23	100.0
ES521301	PENYA-SEGATS DE LA MARINA	31	31	100.0	23	74.2
ES614001	SIERRA DE BAZA NORTE	23	23	100.0	23	100.0
ES620002	SIERRA DE ABANILLA	23	23	100.0	23	100.0
ES620003	CUERDA DE LA SERRATA	23	23	100.0	23	100.0
ES000043	PLA DE SA MOLA	22	22	100.0	22	100.0
ES614000	SIERRA NEVADA NOROESTE	22	22	100.0	22	100.0
ES620004	YESOS DE ULEA	22	22	100.0	22	100.0
ES000024	COSTA DELS AMUNTS	21	21	100.0	20	95.2
ES000026	LLANO DE LAS CABRAS	19	19	100.0	19	100.0
ES000038	PUIG GROS	20	20	100.0	19	95.0
ES000004	PUNTA ENTINAS-SABINAR	39	39	100.0	18	46.2

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES000008	CAP ENDERROCAT-CAP BLANC	80	24	30.0	18	22.5
ES000012	ILLOTS DE BENIDORM I SERRA GELADA	27	27	100.0	18	66.7
ES531010	XORRIGO	18	18	100.0	18	100.0
ES620002	CABEZO DE ROLDÁN	22	22	100.0	18	81.8
ES620004	RAMBLA DE LA ROGATIVA	18	18	100.0	18	100.0
ES521200	SALERO Y CABECICOS DE VILLENA	17	17	100.0	17	100.0
ES531002	LA MOLA	27	27	100.0	17	63.0
ES531007	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	23	100.0	17	73.9
ES620001	CALNEGRE	18	18	100.0	17	94.4
ES521302	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	25	100.0	16	64.0
ES531000	ES TEIX	18	18	100.0	16	88.9
ES531003	XARRACA	19	19	100.0	16	84.2
ES614001	SIERRA DE CASTELL DE FERRO	17	17	100.0	16	94.1
ES620002	SIERRA DE LA FAUSILLA	21	21	100.0	16	76.2
ES620003	MAR MENOR	45	45	100.0	16	35.6
ES000019	SIERRA DE LA FAUSILLA	20	20	100.0	15	75.0
ES000044	DE LA SERRA DE L'ESPERÓ AL PENYAL ALT	34	34	100.0	15	44.1
ES521302	SIERRA DE CALLOSA DE SEGURA	15	15	100.0	15	100.0
ES611001	FONDOS MARINOS LEVANTE ALMERIENSE	26	26	100.0	15	57.7
ES614001	LA MALA	15	15	100.0	15	100.0
ES000007	CAP DE CALA FIGUERA	20	20	100.0	14	70.0
ES521302	TABARCA	24	24	100.0	14	58.3
ES521302	DUNES DE GUARDAMAR	19	19	100.0	14	73.7
ES531008	PUIGPUNYENT	14	14	100.0	14	100.0
ES531008	ES BOIXOS	15	15	100.0	14	93.3
ES620004	CABEZOS DEL PERICÓN	14	14	100.0	14	100.0
ES000017	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	17	100.0	12	70.6
ES000045	IFAC I LITORAL DE LA MARINA	14	14	100.0	12	85.7
ES000046	CLOT DE GALVANY	12	12	100.0	12	100.0
ES521100	IFAC	14	14	100.0	12	85.7
ES531001	COMUNA DE BUNYOLA	15	15	100.0	12	80.0
ES611000	LA SERRETA DE CABO DE GATA	12	12	100.0	12	100.0
ES611001	ARTOS DE EL EJIDO	12	12	100.0	12	100.0
ES000002	L'ALBUFERA	255	11	4.3	11	4.3
ES000022	SA COSTERA	14	14	100.0	11	78.6
ES000047	L'ALBUFERA	255	11	4.3	11	4.3
ES531009	MOSSA	11	11	100.0	11	100.0
ES531010	COSTA DE L'OEST D'EIVISSA	26	26	100.0	11	42.3
ES631000	CALAMOCARRO-BENZÚ	11	11	100.0	11	100.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES531002	CAP DE BARBARIA	18	18	100.0	10	55.6
ES531008	PORT DES CANONGE	14	14	100.0	10	71.4
ES531008	MONCAIRE	10	10	100.0	10	100.0
ES531008	BÀLITX	12	12	100.0	10	83.3
ES000022	L'ALBUFERETA	10	10	100.0	9	90.0
ES531000	BADIES DE POLLENÇA I ALCÚDIA	50	18	36.0	9	18.0
ES531002	FITA DES RAM	9	9	100.0	9	100.0
ES531008	S'ESTACA-PUNTA DE DEIÀ	13	13	100.0	9	69.2
ES531011	ÀREA MARINA PLATJA DE MIGJORN	22	22	100.0	9	40.9
ES611001	RIO ADRA	9	9	100.0	9	100.0
ES000003	S'ALBUFERA DE MALLORCA	39	8	20.5	8	20.5
ES000037	PUIG DE SES FITES	8	8	100.0	8	100.0
ES521200	LAGUNA DE SALINAS	8	8	100.0	8	100.0
ES531009	PUIG D'ALARÒ-PUIG DE S'ALCADENA	12	12	100.0	8	66.7
ES620004	SIERRA DE LAS VICTORIAS	8	8	100.0	8	100.0
ES000037	PUIG DES BOIXOS	7	7	100.0	7	100.0
ES521200	ALGEPSARS DE FINESTRAT	7	7	100.0	7	100.0
ES521303	CABO ROIG	11	11	100.0	7	63.6
ES611001	RIO ANTAS	7	7	100.0	7	100.0
ES620001	CABEZO GORDO	7	7	100.0	7	100.0
ES000022	SA DRAGONERA	15	15	100.0	6	40.0
ES000022	LA TRAPA	10	10	100.0	6	60.0
ES531009	FORMENTOR	7	7	100.0	6	85.7
ES620003	CABO COPE	6	6	100.0	6	100.0
ES000037	MOLA DE SON PACS	5	5	100.0	5	100.0
ES000038	PUIG DES CASTELL	6	6	100.0	5	83.3
ES521303	CAP DE LES HORTES	15	15	100.0	5	33.3
ES531001	PUIG DE SANT MARTÍ	6	5	83.3	5	83.3
ES531007	SERRAL D'EN SALAT	6	6	100.0	5	83.3
ES531010	ÀREA MARINA DE TAGOMAGO	6	6	100.0	5	83.3
ES620001	CUATRO CALAS	6	6	100.0	5	83.3
ES620004	MEDIO MARINO	15	15	100.0	5	33.3
ES000007	ES VEDRÀ-ES VEDRANELL	6	6	100.0	4	66.7
ES000022	SA FORADADA	5	5	100.0	4	80.0
ES000038	PUIG DE S'EXTREMERA	4	4	100.0	4	100.0
ES000038	ALARÓ	4	4	100.0	4	100.0
ES531002	ES BINIS	4	4	100.0	4	100.0
ES611000	ALBUFERA DE ADRA	4	4	100.0	4	100.0
ES632000	BARRANCO DEL NANO	4	4	100.0	4	100.0
ES000004	LOS ALCORNOCALES	1844	40	2.2	3	0.2
ES000008	TAGOMAGO	3	3	100.0	3	100.0
ES000022	MULETA	7	7	100.0	3	42.9

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES531003	PORROIG	3	3	100.0	3	100.0
ES531008	BINIARROI	11	11	100.0	3	27.3
ES531010	ÀREA MARINA DE CALA SAONA	4	4	100.0	3	75.0
ES617000	ACANTILADOS DE MARO-CERRO GORDO	15	15	100.0	3	20.0
ES000021	ILLOTS DE TABARCA	12	12	100.0	2	16.7
ES531008	TORRE PICADA	5	5	100.0	2	40.0
ES531008	MONNÀBER	2	2	100.0	2	100.0
ES531008	GORG BLAU	6	6	100.0	2	33.3
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES531010	ÀREA MARINA DEL CAP MARTINET	7	7	100.0	2	28.6
ES614001	ACANTILADOS Y FONDOS MARINOS DE CALAHONDA-CASTELL DE FERRO	7	7	100.0	2	28.6
ES616001	RIO GUADIANA MENOR - TRAMO SUPERIOR	2	2	100.0	2	100.0
ES617002	RIO GUADALMEDINA	4	4	100.0	2	50.0
ES617003	EL SALADILLO - PUNTA DE BAÑOS	5	5	100.0	2	40.0
ES620000	ISLAS E ISLOTES DEL LITORAL MEDITERRÁNEO	4	4	100.0	2	50.0
ES631000	ZONA MARÍTIMO-TERRESTRE DEL MONTE HACHO	6	6	100.0	2	33.3
ES632000	ZONA MARÍTIMO TERRESTRE DE LOS ACANTILADOS DE AGUADÚ	2	2	100.0	2	100.0
ES000019	ACANTILADOS DEL MONTE HACHO	4	4	100.0	1	25.0
ES521201	ARENAL DE PETRER	1	1	100.0	1	100.0
ES521400	TUNEL DE CANALS	1	1	100.0	1	100.0
ES521400	COVA JOLIANA	1	1	100.0	1	100.0
ES523200	SERRA DEL CASTELL DE XÀTIVA	1	1	100.0	1	100.0
ES523304	COVA DE LES RATES PENADES (RÒTOVA)	1	1	100.0	1	100.0
ES531003	BASSES DE LA MARINA DE LLUCMAJOR	3	1	33.3	1	33.3
ES531004	COVA DE LES MARAVELLES	1	1	100.0	1	100.0
ES531004	AVENC D'EN CORBERA	1	1	100.0	1	100.0
ES531005	COVA DE CAL PESSO	1	1	100.0	1	100.0
ES531005	COVA DE LLENAIRE	1	1	100.0	1	100.0
ES531006	ES BUFADOR DE SON BERENGUER	1	1	100.0	1	100.0
ES531006	COVA DE CAN MILLO O DE COA NEGRINA	1	1	100.0	1	100.0
ES531006	AVENC DE SON POU	1	1	100.0	1	100.0
ES531012	BASSA DE FORMENTERA	1	1	100.0	1	100.0
ES611001	RAMBLA DE AREJOS	1	1	100.0	1	100.0
ES612000	ESTUARIO DEL RIO GUADIARO	3	2	66.7	1	33.3
ES617002	RIO GUADALMINA	1	1	100.0	1	100.0
ES617002	RIO FUENGIROLA	7	7	100.0	1	14.3
ES617003	CALAHONDA	7	7	100.0	1	14.3
ES620003	MINAS DE LA CELIA	1	1	100.0	1	100.0

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES00000З	ISLAS CHAFARINAS	3	3	100.0	0	0.0
ES000020	ISLA GROSA	1	1	100.0	0	0.0
ES000024	ILLOTS DE SANTA EULÀRIA, RODONA I ES CANÀ	2	2	100.0	0	0.0
ES000025	ISLAS HORMIGAS	1	1	100.0	0	0.0
ES531005	COVA DE CAN SION	1	1	100.0	0	0.0
ES531006	COVA MORELLA	1	1	100.0	0	0.0
ES531010	ÀREA MARINA CAP DE CALA FIGUERA	1	1	100.0	0	0.0
ES531011	ÀREA MARINA PLATJA DE TRAMUNTANA	1	1	100.0	0	0.0
ES611000	FONDOS MARINOS DE PUNTA ENTINAS-SABINAR	16	16	100.0	0	0.0
ES612000	MARISMAS DEL RIO PALMONES	4	1	25.0	0	0.0
ES614001	FONDOS MARINOS TESORILLO-SALOBREÑA	6	6	100.0	0	0.0
ES614001	ACANTILADOS Y FONDOS MARINOS DE LA PUNTA DE LA MONA	2	2	100.0	0	0.0
ES616001	RIO GUADIANA MENOR - TRAMO INFERIOR	5	4	80.0	0	0.0
ES617003	RIOS GUADALHORCE, FABALAS Y PEREILAS	12	5	41.7	0	0.0
ES630000	ISLAS CHAFARINAS	3	3	100.0	0	0.0
	SPAIN TOTAL:	31629	23926	75.6	22912	72.4
	OVERALL NATURA 2000 TOTAL:	31629	23926	75.6	22912	72.4

Table C.12: *Euphorbia squamigera* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
902847	Wetlands of International Importance (Ramsar)	Garaet Guellif	268	259	96.6
101170	National Park	Tlemcen	182	182	100.0
14903	Breeding Station	Tlemcen	182	182	100.0
13697	Hunting Reserve	Tlemcen	182	182	100.0
902845	Wetlands of International Importance (Ramsar)	Garaet Annk Djemel et El Merhsel	206	165	80.1
900713	UNESCO-MAB Biosphere Reserve	Chrea	568	138	24.3
9740	National Park	Chrea	568	138	24.3
26620	UNESCO-MAB Biosphere Reserve	El Kala	897	134	14.9
9741	National Park	El Kala	897	134	14.9
14909	Marine Park	El Kala	897	134	14.9
9742	National Park	Belezma	218	103	47.2
902846	Wetlands of International Importance (Ramsar)	Garaet El Taref	369	87	23.6
901223	Wetlands of International Importance (Ramsar)	Chott de Zehrez Chergui	552	85	15.4
9758	Nature Reserve	Macta	207	78	37.7
4118	National Park	Djurdjura	562	74	13.2
145569	UNESCO-MAB Biosphere Reserve	Djurdjura	562	74	13.2
902852	Wetlands of International Importance (Ramsar)	Sebkhet Bazer	58	58	100.0
900575	Wetlands of International Importance (Ramsar)	Marais de la Macta	489	55	11.2
9743	National Park	Taza	52	51	98.1
902530	UNESCO-MAB Biosphere Reserve	Taza	52	51	98.1
12350	Strict Nature Reserve	Babor	49	49	100.0
902844	Wetlands of International Importance (Ramsar)	Dayet El Ferd	46	46	100.0
900574	Wetlands of International Importance (Ramsar)	Complexe de zones humides de la plaine de Guerbes-Sanhadja	432	39	9.0
14904	Breeding Station	Boumerdes	100	37	37.0
902853	Wetlands of International Importance (Ramsar)	Sebkhet El Hamiet	37	37	100.0
72354	National Park	Djebel Aissa	44	36	81.8

Code	Type	Name	PA cells	PSA cells	Perc. PSA
3369	Park	Tipasa-Chenoua Terrestrial and Marine	62	27	43.5
902843	Wetlands of International Importance (Ramsar)	Chott Tinsilt	31	20	64.5
9748	Regional Park	Seraidi P	40	20	50.0
72363	National Park	Tipaza Chenoua	49	19	38.8
72355	National Park	Edough	36	16	44.4
902531	UNESCO-MAB Biosphere Reserve	Gouraya	18	12	66.7
9747	National Park	Gouraya	18	12	66.7
901231	Wetlands of International Importance (Ramsar)	Marais de la Mekhada	106	10	9.4
9755	Marine Park	Jijel	9	9	100.0
72356	National Park	Naama	9	9	100.0
900576	Wetlands of International Importance (Ramsar)	Sebkha d'Oran	617	9	1.5
14905	Other Area	Setif	9	9	100.0
4120	Nature Reserve	Beni-Salah	34	6	17.6
14906	Other Area	Mostaganem	6	6	100.0
72362	National Park	Tigzirt	3	3	100.0
12354	Breeding Station	Reghaia	4	2	50.0
901224	Wetlands of International Importance (Ramsar)	Chott de Zehrez Gharbi	568	1	0.2
12355	Other Area	Lac Tonga	34	1	2.9
72361	National Park	La Salamandre	4	1	25.0
		ALGERIA TOTAL:	10333	2800	27.1
MOROCCO					
168216	UNESCO-MAB Biosphere Reserve	Arganeraie	20690	16457	79.5
220265	UNESCO-MAB Biosphere Reserve	Oasis de Sud Morocain	62356	7899	12.7
4114	National Park	Toubkal	1058	994	94.0
313472	Natural Park	Talassemtane	729	564	77.4
31073	National Park	Parc de Haut Atlas Oriental	438	437	99.8
11697	National Park	Souss-Massa	463	380	82.1
4115	National Park	Tazekka	459	367	80.0
17742	National Park	Talassantane	648	293	45.2
11690	Botanical Reserve	Talassantane	648	293	45.2
29969	National Park	Al Hoceima	271	269	99.3
20371	Marine Reserve	Bokkoyas	268	266	99.3
11698	Biological Reserve	Bokkoyas	268	266	99.3
15089	National Park	Ifrane	621	234	37.7
313471	Natural Park	Ifrane	621	234	37.7

Code	Type	Name	PA cells	PSA cells	Perc. PSA
902705	Wetlands of International Importance (Ramsar)	Complexe de Sidi Moussa-Walidia	89	85	95.5
11689	Biological Reserve	Merja Zerga	71	63	88.7
17710	Wetlands of International Importance (Ramsar)	Merja Zerga	71	63	88.7
902707	Wetlands of International Importance (Ramsar)	Complexe du bas Tahaddart	72	51	70.8
11691	Permanent Hunting Reserve	Sidi Boughaba	51	43	84.3
32551	Biological Reserve	Sidi Boughaba	51	43	84.3
902709	Wetlands of International Importance (Ramsar)	Embouchure de la Moulouya	41	40	97.6
902703	Wetlands of International Importance (Ramsar)	Barrage Mohammed V	64	39	60.9
902715	Wetlands of International Importance (Ramsar)	Sebkha Bou Areg	55	31	56.4
11688	Hunting Reserve	Mouley Bousalham	34	27	79.4
15102	Nature Reserve	Merja Daoura (Merja Sidi Mohammed Ben Mansour) NR	82	26	31.7
15103	Reserve	Rio Martine lagoon	40	23	57.5
11684	Permanent Hunting Reserve	Takherkhort	20	20	100.0
902717	Wetlands of International Importance (Ramsar)	Zones humides de l'oued El Maleh	20	20	100.0
902718	Wetlands of International Importance (Ramsar)	Zones humides de Souss-Massa	18	18	100.0
902704	Wetlands of International Importance (Ramsar)	Cap des Trois Fourches	26	17	65.4
17711	Wetlands of International Importance (Ramsar)	Merja Sidi Boughaba	17	15	88.2
902711	Wetlands of International Importance (Ramsar)	Lacs Isly-Tislite	14	14	100.0
12381	Biological Reserve	Oued Massa	11	11	100.0
902699	Wetlands of International Importance (Ramsar)	Aguelmams Sidi Ali - Tifounassine	9	9	100.0
13423	Reserve	Oualidia et Sidi Moussa	9	9	100.0
15111	Hunting Reserve	Aguelman Sidi Ali	8	8	100.0
902700	Wetlands of International Importance (Ramsar)	Archipel et dunes d'Essawira	13	8	61.5
15113	Hunting Reserve	Dayet Ifrah	8	8	100.0
15095	Nature Reserve	Lac Iseli	8	8	100.0
15117	Nature Reserve	El Merja (Sidi Moussa region)	7	7	100.0
15112	Hunting Reserve	Dayet el Hachlef	6	6	100.0

Code	Type	Name	PA cells	PSA cells	Perc. PSA
13699	Reserve	Tidhirine	6	6	100.0
15093	Hunting Reserve	Dayet Agoulman	4	4	100.0
15116	Nature Reserve	El Holba	4	4	100.0
17712	Wetlands of International Importance (Ramsar)	Lac d'Afennourir	19	4	21.1
15096	Nature Reserve	Lac Tislit	4	4	100.0
15106	Nature Reserve	Oued Loukkos	5	4	80.0
15109	Hunting Reserve	Dayet Afougha	3	3	100.0
15099	Nature Reserve	Nador	21	3	14.3
902706	Wetlands of International Importance (Ramsar)	Complexe du bas Loukkos	49	2	4.1
15108	Hunting Reserve	Dayet Aaoua	2	2	100.0
902997	UNESCO-MAB Biosphere Reserve	Intercontinental BR of the Mediterranean	8	2	25.0
15115	Nature Reserve	Sidi Rahat	5	2	40.0
15118	Nature Reserve	Aguelmam Tifounassine	1	1	100.0
11692	Permanent Hunting Reserve	Ile de Skhirate	1	1	100.0
		MOROCCO TOTAL:	90585	29707	32.8
TUNISIA					
903084	Wetlands of International Importance (Ramsar)	Sebkhet Kelbia	238	232	97.5
15185	Wetland Zone of National Importance	Sebkhet Kelbia	238	232	97.5
15188	Nature Reserve	Lac Bizerte	90	71	78.9
15182	Nature Reserve	Medjerda Estuary	66	61	92.4
15187	Wetland Zone of National Importance	Sebkhet-Sidi-El-Hani	388	59	15.2
903080	Wetlands of International Importance (Ramsar)	Lagune de Ghar el Melh et DElta de la Mejerda	71	58	81.7
32554	Wetland Zone of National Importance	Sebkhet Ariana	43	43	100.0
903086	Wetlands of International Importance (Ramsar)	Sebkhet Sejoumi	42	42	100.0
15183	Wetland Zone of National Importance	Sebkhet es Sedjoumi	36	36	100.0
12390	National Park	Boukornine	24	24	100.0
15194	Wetland Zone of National Importance	Sebkha Halk el Menzel	20	20	100.0
15184	Wetland Zone of National Importance	Sebkhet Kourzia	25	19	76.0

Code	Type	Name	PA cells	PSA cells	Perc. PSA
903072	Wetlands of International Importance (Ramsar)	Barrage Lebna	16	16	100.0
903087	Wetlands of International Importance (Ramsar)	Sebkhet Soliman	14	14	100.0
17744	National Park	El-Feidja	39	10	25.6
903081	Wetlands of International Importance (Ramsar)	Lagunes du Cap Bon oriental	8	8	100.0
15193	Nature Reserve	Cap Bon peninsula	6	6	100.0
15202	Nature Reserve	Djebel Zaghouan	6	6	100.0
12392	Faunal Reserve	Dar Chichou	4	4	100.0
2115	UNESCO-MAB Biosphere Reserve	Iles Zembra et Zembretta	8	2	25.0
365017	Barcelona Convention	Zembra and Zembretta	8	2	25.0
942	National Park	Zembra and Zembretta	8	2	25.0
15203	Nature Reserve	Dar Fatma	1	1	100.0
101847	Natural Reserve	Grotte de Chauve souris d'El Haouaria	1	1	100.0
941	National Park	Ichkeul	150	1	0.7
17719	Wetlands of International Importance (Ramsar)	Ichkeul	150	1	0.7
		TUNISIA TOTAL:	1700	971	57.1
		OVERALL NORTH AFRICAN TOTAL:	102618	33478	32.6

Table C.13: *Euphorbia squamigera* EOO and AOO protection by North African protected areas

Code	Type	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ALGERIA							
10117	National Park	Tlemcen	182	182	100.0	182	100.0
14903	Breeding Station	Tlemcen	182	182	100.0	182	100.0
13697	Hunting Reserve	Tlemcen	182	182	100.0	182	100.0
9758	Nature Reserve	Macta	207	182	87.9	78	37.7
90057	Wetlands of International Importance (Ramsar)	Marais de la Macta	489	436	89.2	55	11.2
90057	Wetlands of International Importance (Ramsar)	Sebkha d'Oran	617	617	100.0	9	1.5
14906	Other Area	Mostaganem	6	5	83.3	5	83.3
72354	National Park	Djebel Aissa	44	1	2.3	1	2.3
36501	Barcelona Convention	Iles Habibas	4	4	100.0	0	0.0
19571	Marine Nature Reserve	Iles Habibas	4	4	100.0	0	0.0
		ALGERIA TOTAL:	1917	1795	93.6	694	36.2
MOROCCO							
16821	UNESCO-MAB Biosphere Reserve	Arganeraie	20690	5884	28.4	4081	19.7
4114	National Park	Toubkal	1058	1058	100.0	994	94.0
31347	Natural Park	Talassemtane	729	729	100.0	564	77.4
31073	National Park	Parc de Haut Atlas Oriental	438	377	86.1	376	85.8
4115	National Park	Tazekka	459	459	100.0	367	80.0
11690	Botanical Reserve	Talassantane	648	648	100.0	293	45.2
17742	National Park	Talassantane	648	648	100.0	293	45.2
29969	National Park	Al Hoceima	271	271	100.0	269	99.3
11698	Biological Reserve	Bokkoyas	268	268	100.0	266	99.3
20371	Marine Reserve	Bokkoyas	268	268	100.0	266	99.3
15089	National Park	Ifrane	621	621	100.0	234	37.7
31347	Natural Park	Ifrane	621	621	100.0	234	37.7
11689	Biological Reserve	Merja Zerga	71	71	100.0	63	88.7
17710	Wetlands of International Importance (Ramsar)	Merja Zerga	71	71	100.0	63	88.7
90270	Wetlands of International Importance (Ramsar)	Complexe du bas Tahaddart	72	72	100.0	51	70.8
11691	Permanent Hunting Reserve	Sidi Boughaba	51	51	100.0	43	84.3
32551	Biological Reserve	Sidi Boughaba	51	51	100.0	43	84.3

Code	Type	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
90270	Wetlands of International Importance (Ramsar)	Embouchure de la Moulouya	41	41	100.0	40	97.6
90270	Wetlands of International Importance (Ramsar)	Barrage Mohammed V	64	64	100.0	39	60.9
90271	Wetlands of International Importance (Ramsar)	Sebkha Bou Areg	55	55	100.0	31	56.4
11688	Hunting Reserve	Mouley Bousalham	34	34	100.0	27	79.4
15102	Nature Reserve	Merja Daoura (Merja Sidi Mohammed Ben Mansour) NR	82	82	100.0	26	31.7
15103	Reserve	Rio Martine lagoon	40	40	100.0	23	57.5
11684	Permanent Hunting Reserve	Takherkhort	20	20	100.0	20	100.0
90270	Wetlands of International Importance (Ramsar)	Cap des Trois Fourches	26	26	100.0	17	65.4
17711	Wetlands of International Importance (Ramsar)	Merja Sidi Boughaba	17	17	100.0	15	88.2
90271	Wetlands of International Importance (Ramsar)	Lacs Isly-Tislite	14	14	100.0	14	100.0
90269	Wetlands of International Importance (Ramsar)	Aguelmams Sidi Ali - Tifounassine	9	9	100.0	9	100.0
15111	Hunting Reserve	Aguelman Sidi Ali	8	8	100.0	8	100.0
15113	Hunting Reserve	Dayet Ifrah	8	8	100.0	8	100.0
15095	Nature Reserve	Lac Iseli	8	8	100.0	8	100.0
15112	Hunting Reserve	Dayet el Hachlef	6	6	100.0	6	100.0
13699	Reserve	Tidhirine	6	6	100.0	6	100.0
15093	Hunting Reserve	Dayet Agoulman	4	4	100.0	4	100.0
17712	Wetlands of International Importance (Ramsar)	Lac d'Afennourir	19	19	100.0	4	21.1
15096	Nature Reserve	Lac Tislit	4	4	100.0	4	100.0
15106	Nature Reserve	Oued Loukkos	5	5	100.0	4	80.0
15109	Hunting Reserve	Dayet Afougha	3	3	100.0	3	100.0
15099	Nature Reserve	Nador	21	21	100.0	3	14.3
90270	Wetlands of International Importance (Ramsar)	Complexe du bas Loukkos	49	49	100.0	2	4.1
15108	Hunting Reserve	Dayet Aaoua	2	2	100.0	2	100.0
90299	UNESCO-MAB Biosphere Reserve	Intercontinental BR of the Mediterranean	8	8	100.0	2	25.0
15118	Nature Reserve	Aguelmam Tifounassine	1	1	100.0	1	100.0
11692	Permanent Hunting Reserve	Ile de Skhirate	1	1	100.0	1	100.0
90271	Wetlands of International Importance (Ramsar)	Zones humides de l'oued El Maleh	20	1	5.0	1	5.0

Code	Type	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
12379	Permanent Hunting Reserve	Affenourir	8	8	100.0	0	0.0
15091	National Park	Aguelman Azigza	4	4	100.0	0	0.0
90270	Wetlands of International Importance (Ramsar)	Barrage Al Massira	166	166	100.0	0	0.0
15090	National Park	Bou Tferda	30	30	100.0	0	0.0
15114	Nature Reserve	Sebkhet Sidi Bou Areg	2	2	100.0	0	0.0
15092	National Park	Tidhirine (Tidiquin)	7	7	100.0	0	0.0
11696	Forest Sanctuary (Zakaznik)	Zemzem	122	122	100.0	0	0.0
		MOROCCO TOTAL:	27949	13063	46.7	8828	31.6
		OVERALL NORTH AFRICAN TOTAL:	29866	14858	49.7	9522	31.9

Helianthemum caput-felis

Table C.14: *Helianthemum caput-felis* PSA protection by Natura 2000

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000023	L'ALBUFERA	255	84	32.9
ES0000471	L'ALBUFERA	255	84	32.9
ES0000046	CABO DE GATA-NIJAR	477	70	14.7
ES0000073	COSTA BRAVA DE MALLORCA	143	58	40.6
ES0000081	CAP ENDERROCAT-CAP BLANC	80	58	72.5
ES0000020	DELTA DE L'EBRE	223	57	25.6
ES0000264	SIERRA DE LA MUELA Y CABO TIÑOSO	147	52	35.4
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	47	61.8
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES6200015	LA MUELA Y CABO TIÑOSO	110	38	34.5
ES6200029	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	38	54.3
ES0000228	CAP DE SES SALINES	60	37	61.7
ES0000260	MAR MENOR	67	37	55.2
ES0000231	DELS ALOCS A FORNELLS	52	35	67.3
ES6200001	CALBLANQUE, MONTE DE LAS CENIZAS Y PEÑA DEL ÁGUILA	52	35	67.3
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES5310032	CAP LLENTRISCA-SA TALAIA	50	32	64.0
ES6110012	SIERRAS ALMAGRERA, DE LOS PINOS Y EL AGUILON	87	30	34.5
ES0000227	MUNTANYES D'ARTÀ	129	28	21.7
ES0000024	DOÑANA	1310	26	2.0
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	26	17.4
ES6200006	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	26	65.0
ES0000318	CABO BUSTO-LUANCO	138	25	18.1
ES5233030	MARJAL DE LA SAFOR	24	23	95.8
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	23	67.6
ES0000317	PENARRONDA-BARAYO	64	22	34.4
ES5310112	NORD DE SANT JOAN	26	22	84.6
ES6110005	SIERRA DE CABRERA-BEDAR	413	22	5.3
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	19	59.4
ES5223007	MARJAL D'ALMENARA	32	19	59.4
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	19	38.0
ES0000120	SALINAS DE SANTA POLA.	44	18	40.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES0000230	LA VALL	74	18	24.3
ES0000237	DES CANUTELLS A LLUCALARI	45	18	40.0
ES5213018	PENYA-SEGATS DE LA MARINA	31	18	58.1
ES6170007	SIERRAS DE TEJEDA, ALMIJARA Y ALHAMA	480	18	3.8
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	17	65.4
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	17	42.5
ES5211007	MONTGÓ	40	17	42.5
ES5310024	LA MOLA	27	17	63.0
ES5310113	LA VALL	46	17	37.0
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5222005	MARJAL DE NULES	19	16	84.2
ES5310033	XARRACA	19	16	84.2
ES6200025	SIERRA DE LA FAUSILLA	21	16	76.2
ES6200030	MAR MENOR	45	16	35.6
ES0000199	SIERRA DE LA FAUSILLA	20	15	75.0
ES0000261	SIERRA DE ALMENARA, MORERAS Y CABO COPE	327	15	4.6
ES6110010	FONDOS MARINOS LEVANTE ALMERIENSE	26	15	57.7
ES6200024	CABEZO DE ROLDÁN	22	15	68.2
ES0000038	S'ALBUFERA DE MALLORCA	39	14	35.9
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000147	MARJAL DE PEGO-OLIVA.	24	14	58.3
ES0000148	MARJAL DELS MOROS.	15	14	93.3
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000470	MARJAL DELS MOROS	15	14	93.3
ES5213025	DUNES DE GUARDAMAR	19	14	73.7
ES6200012	CALNEGRE	18	14	77.8
ES0000235	DE S'ALBUFERA A LA MOLA	41	13	31.7
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	13	56.5
ES0000059	LLACUNES DE LA MATA I TORREVIEJA.	60	12	20.0
ES0000175	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	12	70.6
ES0000444	SERRA D'IRTA	105	12	11.4
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES5211009	IFAC	14	12	85.7
ES5223036	SERRA D'IRTA	105	12	11.4
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310098	CALES DE MANACOR	16	12	75.0
ES6140011	SIERRA DE CASTELL DE FERRO	17	12	70.6
ES0000145	MONDRAGÓ	15	11	73.3
ES0000233	D'ADDAIA A S'ALBUFERA	35	11	31.4
ES0000238	SON BOU I BARRANC DE SA VALL	29	11	37.9
ES0000453	MUNTANYES DE LA MARINA	557	11	2.0
ES5120007	CAP DE CREUS	155	11	7.1

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310104	COSTA DE L'OEST D'EIVISSA	26	11	42.3
ES6200011	SIERRA DE LAS MORERAS	50	11	22.0
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	10	55.6
ES0000467	PRAT DE CABANES I TORREBLANCA	18	10	55.6
ES1110005	COSTA DA MORTE	227	10	4.4
ES5120016	EL MONTGRÍ- LES MEDES - EL BAIX TER	77	10	13.0
ES5212012	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	10	13.0
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6
ES0000239	DE BINIGAUS A CALA MITJANA	48	9	18.8
ES5310068	CAP NEGRE	9	9	100.0
ES5310081	PORT DES CANONGE	14	9	64.3
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES6150005	MARISMAS DE ISLA CRISTINA	43	9	20.9
ES0000025	MARISMAS DEL ODIEL	92	8	8.7
ES0000079	LA VICTÒRIA	16	8	50.0
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	8	27.6
ES0000372	COSTA DA MARIÑA OCCIDENTAL	36	8	22.2
ES0000464	SIERRA ESCALONA Y DEHESA DE CAMPOAMOR	136	8	5.9
ES1120017	COSTA DA MARIÑA OCCIDENTAL	38	8	21.1
ES5213020	SERRES DEL FERRER I BÈRNIA	57	8	14.0
ES5213024	TABARCA	24	8	33.3
ES5310029	NA BORGES	69	8	11.6
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	8	61.5
ES6110008	SIERRAS DE GADOR Y ENIX	598	8	1.3
ES0000226	L'ALBUFERETA	10	7	70.0
ES0000240	COSTA SUD DE CIUTADELLA	25	7	28.0
ES0000443	SUD DE CIUTADELLA	38	7	18.4
ES1110002	COSTA ÁRTABRA	187	7	3.7
ES5213033	CABO ROIG	11	7	63.6
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES6150006	MARISMAS DEL RIO PIEDRAS Y FLECHA DEL ROMPIDO	55	7	12.7
ES0000019	AIGUAMOLLS DE L'ALT EMPORDÀ	89	6	6.7
ES0000221	SA DRAGONERA	15	6	40.0
ES0000222	LA TRAPA	10	6	60.0
ES0000462	CLOT DE GALVANY	12	6	50.0
ES1120005	AS CATEDRAIS	17	6	35.3
ES5140001	LITORAL MERIDIONAL TARRAGONÍ	20	6	30.0
ES5310008	ES GALATZÓ-S'ESCLOP	36	6	16.7
ES6200031	CABO COPE	6	6	100.0
ES0000225	SA COSTERA	14	5	35.7
ES0000234	S'ALBUFERA DES GRAU	31	5	16.1
ES5140007	COSTES DEL TARRAGONÈS	14	5	35.7

Code	Name	PA cells	PSA cells	Perc. PSA
ES5213032	CAP DE LES HORTES	15	5	33.3
ES5222002	MARJAL DE PENÍSCOLA	5	5	100.0
ES5310087	BÀLITX	12	5	41.7
ES5310093	FORMENTOR	7	5	71.4
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES6110017	RIO ANTAS	7	5	71.4
ES6200010	CUATRO CALAS	6	5	83.3
ES6200048	MEDIO MARINO	15	5	33.3
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000176	COSTA DA MORTE (NORTE)	107	4	3.7
ES0000223	SA FORADADA	5	4	80.0
ES1110010	ESTACA DE BARES	25	4	16.0
ES5120013	MASSÍS DE LES CADIRETES	122	4	3.3
ES5120015	LITORAL DEL BAIX EMPORDÀ	51	4	7.8
ES5232007	RIU XÚQUER	74	4	5.4
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310076	SERRAL D'EN SALAT	6	4	66.7
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES6320002	BARRANCO DEL NANO	4	4	100.0
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000085	RIBADEO	39	3	7.7
ES0000086	RÍA DE ORTIGUEIRA E LADRIDO	41	3	7.3
ES0000224	MULETA	7	3	42.9
ES0000258	COSTA DE FERROLTERRA - VALDOVIÑO	58	3	5.2
ES1110001	ORTIGUEIRA - MERA	69	3	4.3
ES1200016	RÍA DEL EO	33	3	9.1
ES5213042	VALLS DE LA MARINA	212	3	1.4
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	3	2.5
ES5310031	PORROIG	3	3	100.0
ES5310034	SERRA GROSSA	25	3	12.0
ES5310099	PORTOCOLOM	5	3	60.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES6110001	ALBUFERA DE ADRA	4	3	75.0
ES6150002	ENEBRALES DE PUNTA UMBRIA	7	3	42.9
ES6170002	ACANTILADOS DE MARO-CERRO GORDO	15	3	20.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	2	13.3
ES0000214	ILLOTS DE TABARCA	12	2	16.7
ES1120011	RÍA DE FOZ - MASMA	26	2	7.7
ES5140004	SÈQUIA MAJOR	4	2	50.0

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310015	PUIG DE SANT MARTÍ	6	2	33.3
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310084	TORRE PICADA	5	2	40.0
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES6140014	ACANTILADOS Y FONDOS MARINOS DE CALAHONDA-CASTELL DE FERRO	7	2	28.6
ES6150001	LAGUNA DEL PORTIL	23	2	8.7
ES6150015	ISLA DE SAN BRUNO	8	2	25.0
ES6150028	ESTUARIO DEL RIO PIEDRAS	14	2	14.3
ES6150029	ESTUARIO DEL RIO TINTO	18	2	11.1
ES6200007	ISLAS E ISLOTES DEL LITORAL MEDITERRÁNEO	4	2	50.0
ES6320001	ZONA MARÍTIMO TERRESTRE DE LOS ACANTILADOS DE AGUADÚ	2	2	100.0
ES0000146	DELTA DEL LLOBREGAT	28	1	3.6
ES0000447	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES1110009	COSTA DE DEXO	9	1	11.1
ES1120002	RÍO EO	59	1	1.7
ES5110013	SERRES DEL LITORAL CENTRAL	375	1	0.3
ES5110020	COSTES DEL GARRAF	12	1	8.3
ES5120011	RIBERES DEL BAIX TER	80	1	1.2
ES5120014	L'ALBERA	225	1	0.4
ES5140020	GRAPISSAR DE LA MASIA BLANCA	4	1	25.0
ES5140022	BARRANC DE SANTES CREUS	9	1	11.1
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5223037	COSTA D'ORPESA I BENICÀSSIM	6	1	16.7
ES5233013	SERRA DE CORBERA	83	1	1.2
ES5310028	ES BINIS	4	1	25.0
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	1	33.3
ES5310050	COVA D'EN BESSÓ	1	1	100.0
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310083	ES BOIXOS	15	1	6.7
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310115	ES MOLINET	2	1	50.0
ES5310123	BASSA DE FORMENTERA	1	1	100.0
ES6110016	RAMBLA DE AREJOS	1	1	100.0
ES6150018	RIO GUADIANA Y RIBERA DE CHANZA	97	1	1.0

Code	Name	PA cells	PSA cells	Perc. PSA
	SPAIN TOTAL:	12310	2363	19.2
FRANCE				
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	53	26.2
FR9101440	COMPLEXE LAGUNAIRE DE BAGES-SIGEAN	106	43	40.6
FR9112007	ETANGS DU NARBONNAIS	142	43	30.3
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	41	22.7
FR9301613	RADE D'HYERES	141	33	23.4
FR9310020	ILES D'HYÈRES	130	29	22.3
FR9101463	COMPLEXE LAGUNAIRE DE SALSES	89	27	30.3
FR9112005	COMPLEXE LAGUNAIRE DE SALSES-LEUCATE	85	27	31.8
FR9400570	AGRIATES	151	27	17.9
FR9402013	PLATEAU DU CAP CORSE	40	24	60.0
FR9412009	PLATEAU DU CAP CORSE	32	20	62.5
FR9402017	GOLFE D'AJACCIO	66	16	24.2
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	16	24.2
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	15	37.5
FR9400592	VENTILEGNE-LA TRINITE DE BONIFACIO-FAZZIO	46	14	30.4
FR9400568	CAP CORSE NORD ET ILE FINOCCHIAROLA, GIRAGLIA ET CAPENSE (COTE DE MACINAGGIO A C	47	13	27.7
FR9410098	URBINO	41	13	31.7
FR9410097	ILES FINOCCHIAROLA ET CÔTE NORD	27	11	40.7
FR9402001	CAMPOMORO-SENETOSA	40	10	25.0
FR9402015	BOUCHES DE BONIFACIO, ILES DES MOINES	87	10	11.5
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	10	40.0
FR9410021	ILES LAVEZZI, BOUCHES DE BONIFACIO	111	10	9.0
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	9	42.9
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	9	40.9
FR9101481	COTE ROCHEUSE DES ALBERES	28	8	28.6
FR9402016	POINTE DE SENETOSA ET PROLONGEMENTS	35	7	20.0
FR9400571	ETANG DE BIGUGLIA	37	6	16.2
FR9101441	COMPLEXE LAGUNAIRE DE LAPALME	31	5	16.1
FR9112006	ETANG DE LAPALME	55	5	9.1
FR9112034	CAP BEAR- CAP CERBERE	16	5	31.2
FR9301592	CAMARGUE	884	5	0.6
FR9310019	CAMARGUE	899	5	0.6
FR9400572	MUCCHIATANA	9	5	55.6
FR9400593	ROCCAPINA-ORTOLO	24	5	20.8
FR9410101	ETANG DE BIGUGLIA	35	5	14.3
FR9301590	LE RHONE AVAL	318	4	1.3

Code	Name	PA cells	PSA cells	Perc. PSA
FR9400590	TRE PADULE DE SUARTONE, RONDINARA	11	4	36.4
FR9402010	BAIE DE STAGNOLU, GOLFU DI SOGNU, GOLFE DE PORTO-VECCHIO	20	4	20.0
FR9101465	COMPLEXE LAGUNAIRE DE CANET	31	3	9.7
FR9112025	COMPLEXE LAGUNAIRE DE CANET-SAINT NAZAIRE	31	3	9.7
FR9400591	PLATEAU DE PERTUSATO/ BONIFACIO ET ILES LAVEZZI	37	3	8.1
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	3	27.3
FR9400609	ILES ET POINTE BRUZZI, ETANGS DE CHEVANU ET D'ARBITRU	10	3	30.0
FR9400616	JUNIPERAIE DE PORTO POLLO ET PLAGE DE CUPABIA	9	3	33.3
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9400619	CAMPO DELL'ORO (AJACCIO)	3	3	100.0
FR9402012	CAPO DI FENO	29	3	10.3
FR9101442	PLATEAU DE LEUCATE	9	2	22.2
FR9101483	MASSIF DES ALBERES	103	2	1.9
FR9101493	EMBOUCHURE DU TECH ET GRAU DE LA MASSANE	14	2	14.3
FR9112023	MASSIF DES ALBERES	105	2	1.9
FR9301998	BAIE DE LA CIOTAT	10	2	20.0
FR9301999	COTE BLEUE MARINE	30	2	6.7
FR9312007	ILES MARSEILLAISES - CASSIDAIGNE	45	2	4.4
FR9400586	EMBOUCHURE DU STABIACCU, DOMAINE PUBLIC MARITIME ET ÎLOT ZIGLIONE	6	2	33.3
FR9400594	SITES A ANCHUSA CRISPA DE L'EMBOUCHURE DU RIZZANESE ET D'OLMETO	5	2	40.0
FR9400610	EMBOUCHURE DU TARAVO, PLAGE DE TENUTELLA ET ETANG DE TANCHICCIA	9	2	22.2
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9101453	MASSIF DE LA CLAPE	113	1	0.9
FR9102012	PROLONGEMENT EN MER DES CAP ET ETANG DE LEUCATE	4	1	25.0
FR9110080	MONTAGNE DE LA CLAPE	120	1	0.8
FR9110108	BASSE PLAINE DE L'AUDE	72	1	1.4
FR9112030	PLATEAU DE LEUCATE	8	1	12.5
FR9112035	COTE LANGUEDOCIENNE	44	1	2.3
FR9301609	LA POINTE FAUCONNIERE	11	1	9.1
FR9301610	CAP SICIE - SIX FOURS	18	1	5.6
FR9301996	CAP FERRAT	19	1	5.3
FR9400602	BASSE VALLÉE DU TAVIGNANO	55	1	1.8
	FRANCE TOTAL:	5313	655	12.3
ITALY				
ITA010029	MONTE COFANO, CAPO SAN VITO E MONTE SPARAGIO	218	61	28.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITB030032	STAGNO DI CORRU S'ITTIRI	69	52	75.4
ITB030036	STAGNO DI CABRAS	60	45	75.0
ITB034008	STAGNO DI CABRAS	50	40	80.0
ITA010027	ARCIPELAGO DELLE EGADI - AREA MARINA E TERRESTRE	77	38	49.4
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	37	44.0
ITA010017	CAPO SAN VITO, MONTE MONACO, ZINGARO, FARAGLIONI SCOPELLO, MONTE SPARACIO	108	37	34.3
ITB040027	ISOLA DI SAN PIETRO	72	36	50.0
ITB040029	COSTA DI NEBIDA	116	35	30.2
IT5160102	ELBA ORIENTALE	83	26	31.3
ITB012211	ISOLA ROSSA - COSTA PARADISO	66	26	39.4
ITB040023	STAGNO DI CAGLIARI, SALINE DI MACCHIAREDDU, LAGUNA DI SANTA GILLA	83	26	31.3
ITB040025	PROMONTORIO, DUNE E ZONA UMIDA DI PORTO PINO	40	26	65.0
ITB010043	COSTE E ISOLETTE A NORD OVEST DELLA SARDEGNA	48	25	52.1
IT51A0023	ISOLA DEL GIGLIO	34	23	67.6
ITA010028	STAGNONE DI MARSALA E SALINE DI TRAPANI - AREA MARINA E TERRESTRE	55	23	41.8
ITB010001	ISOLA ASINARA	86	23	26.7
ITB010042	CAPO CACCIA (CON LE ISOLE FORADADA E PIANA) E PUNTA DEL GIGLIO	75	23	30.7
ITB010082	ISOLA DELL'ASINARA	91	23	25.3
IT51A0026	LAGUNA DI ORBETELLO	58	22	37.9
ITA010024	FONDALI DELL'ISOLA DI FAVIGNANA	36	22	61.1
ITA050012	TORRE MANFRIA, BIVIERE E PIANA DI GELA	227	22	9.7
ITB010004	FOCI DEL COGHINAS	38	22	57.9
ITA010004	ISOLA DI FAVIGNANA	33	21	63.6
ITB033036	COSTA DI CUGLIERI	41	21	51.2
ITB040022	STAGNO DI MOLENTARGIUS E TERRITORI LIMITROFI	30	21	70.0
ITB044003	STAGNO DI CAGLIARI	57	21	36.8
ITB034004	CORRU S'ITTIRI, STAGNO DI S. GIOVANNI E MARCEDDÌ	26	20	76.9
ITB010006	MONTE RUSSU	39	19	48.7
ITB040024	ISOLA ROSSA E CAPO TEULADA	48	19	39.6
ITA020050	PARCO DELLE MADONIE	514	18	3.5
ITB010008	ARCIPELAGO LA MADDALENA	126	18	14.3
IT5160012	MONTE CAPANNE E PROMONTORIO DELL'ENFOLA	95	17	17.9
ITB020014	GOLFO DI OROSEI	307	17	5.5
ITB040071	DA PISCINAS A RIU SCIVU	39	17	43.6
ITB044002	SALINE DI MOLENTARGIUS	24	17	70.8
IT9110005	ZONE UMIDE DELLA CAPITANATA	202	16	7.9
IT9110038	PALUDI PRESSO IL GOLFO DI MANFREDONIA	205	16	7.8

Code	Name	PA cells	PSA cells	Perc. PSA
ITA070001	FOCE DEL FIUME SIMETO E LAGO GORNALUNGA	37	16	43.2
ITB010003	STAGNO E GINEPRETO DI PLATAMONA	28	16	57.1
ITB020041	ENTROTERRA E ZONA COSTIERA TRA BOSA, CAPO MARARGIU E PORTO TANGONE	337	16	4.7
ITA070029	BIVIERE DI LENTINI, TRATTO MEDIANO E FOCE DEL FIUME SIMETO E AREA ANTISTANTE LA	94	15	16.0
ITB043035	COSTA E ENTROTERRA TRA PUNTA CANNONI E PUNTA DELLE OCHE - ISOLA DI SAN PIETRO	28	15	53.6
ITB032228	IS ARENAS	20	14	70.0
ITB013044	CAPO CACCIA	51	13	25.5
ITB020012	BERCHIDA E BIDDEROSA	37	13	35.1
ITB040031	MONTE ARCUENTU E RIO PISCINAS	138	13	9.4
ITA010007	SALINE DI TRAPANI	25	12	48.0
ITB010002	STAGNO DI PILO E DI CASARACCIO	28	12	42.9
ITB011155	LAGO DI BARATZ - PORTO FERRO	25	12	48.0
ITB013019	ISOLE DEL NORD - EST TRA CAPO CERASO E STAGNO DI SAN TEODORO	67	12	17.9
ITB020015	AREA DEL MONTE FERRU DI TERTENIA	41	12	29.3
ITB030034	STAGNO DI MISTRAS DI ORISTANO	25	12	48.0
ITB040030	CAPO PECORA	55	12	21.8
IT5160014	ISOLA DI MONTECRISTO	20	11	55.0
IT5160017	ISOLA DI MONTECRISTO E FORMICA DI MONTECRISTO - AREA TERRESTRE E MARINA	20	11	55.0
ITA010002	ISOLA DI MARETTIMO	24	11	45.8
ITA010011	SISTEMA DUNALE CAPO GRANITOLA, PORTO PALO E FOCE DEL BELICE	31	11	35.5
ITA050001	BIVIERE E MACCONI DI GELA	55	11	20.0
ITA070004	TIMPA DI ACIREALE	13	11	84.6
ITB013012	STAGNO DI PILO, CASARACCIO E SALINE DI STINTINO	24	11	45.8
ITB030035	STAGNO DI SALE 'E PORCUS	15	11	73.3
ITB034007	STAGNO DI SALE E' PORCUS	14	11	78.6
IT5160013	ISOLA DI PIANOSA	21	10	47.6
IT5160016	ISOLA DI PIANOSA - AREA TERRESTRE E MARINA	22	10	45.5
IT9320302	MARCHESATO E FIUME NETO	809	10	1.2
ITA010005	LAGHETTI DI PREOLA E GORGHI TONDI E SCIARE DI MAZARA	40	9	22.5
ITA010010	MONTE SAN GIULIANO	20	9	45.0
ITA010015	COMPLESSO MONTI DI CASTELLAMMARE DEL GOLFO (TP)	44	9	20.5
ITA010031	LAGHETTI DI PREOLA E GORGHI TONDI, SCIARE DI MAZARA E PANTANO LEONE	42	9	21.4
ITA020018	FOCE DEL FIUME POLLINA E MONTE TARDARA	41	9	22.0

Code	Name	PA cells	PSA cells	Perc. PSA
ITA040003	FOCE DEL MAGAZZOLO, FOCE DEL PLATANI, CAPO BIANCO, TORRE SALSA	34	9	26.5
ITB023037	COSTA E ENTROTERRA DI BOSA, SUNI E MONTRESTA	126	9	7.1
ITB030016	STAGNO DI S'ENA ARRUBIA E TERRITORI LIMITROFI	9	9	100.0
ITB040017	STAGNI DI MURTAS E S'ACQUA DURCI	15	9	60.0
ITB042226	STAGNO DI PORTO BOTTE	18	9	50.0
ITB043032	ISOLA DI SANT'ANTIOCO, CAPO SPERONE	23	9	39.1
IT9130004	MAR PICCOLO	39	8	20.5
IT9130006	PINETE DELL'ARCO IONICO	67	8	11.9
IT9320095	FOCE NETO	15	8	53.3
ITA010016	MONTE COFANO E LITORALE	13	8	61.5
ITA010021	SALINE DI MARSALA	14	8	57.1
ITA050011	TORRE MANFRIA	24	8	33.3
ITB022214	LIDO DI ORRÌ	9	8	88.9
ITB034006	STAGNO DI MISTRAS	16	8	50.0
ITB042250	DA IS ARENAS A TONNARA (MARINA DI GONNESA)	8	8	100.0
ITA010006	PALUDI DI CAPO FETO E MARGI SPANÒ	15	7	46.7
ITA040010	LITORALE DI PALMA DI MONTECHIARO	19	7	36.8
ITA090008	CAPO MURRO DI PORCO, PENISOLA DELLA MADDALENA E GROTTA PELLEGRINO	9	7	77.8
ITB032219	SASSU - CIRRAS	7	7	100.0
ITB042247	IS COMPINXIUS - CAMPO DUNALE DI BUGERRU - PORTIXEDDU	11	7	63.6
IT9110015	DUNA E LAGO DI LESINA - FOCE DEL FORTORE	148	6	4.1
ITA010001	ISOLE DELLO STAGNONE DI MARSALA	19	6	31.6
ITA010025	FONDALI DEL GOLFO DI CUSTONACI	11	6	54.5
ITA020038	SUGHERETE DI CONTRADA SERRADAINO	12	6	50.0
ITA090006	SALINE DI SIRACUSA E FIUME CIANE	13	6	46.2
ITA090026	FONDALI DI BRUCOLI - AGNONE	12	6	50.0
ITA090029	PANTANI DELLA SICILIA SUD-ORIENTALE, MORGHELLA, DI MARZAMEMI, DI PUNTA PILIERI E	80	6	7.5
ITB034001	STAGNO DI S'ENA ARRUBIA	6	6	100.0
ITB040021	COSTA DI CAGLIARI	44	6	13.6
ITB043025	STAGNI DI COLOSTRAI	36	6	16.7
ITA010003	ISOLA DI LEVANZO	12	5	41.7
ITA010026	FONDALI DELL'ISOLA DELLO STAGNONE DI MARSALA	16	5	31.2
ITA030043	MONTI NEBRODI	819	5	0.6
ITA070028	FONDALI DI ACICASTELLO (ISOLA LACHEA - CICLOPI)	7	5	71.4
ITA090002	VENDICARI	30	5	16.7
ITA090007	CAVA GRANDE DEL CASSIBILE, CAVA CINQUE PORTE, CAVA E BOSCO DI BAULI	89	5	5.6
ITB010011	STAGNO DI SAN TEODORO	15	5	33.3
ITB020013	PALUDE DI OSALLA	23	5	21.7

Code	Name	PA cells	PSA cells	Perc. PSA
ITB030038	STAGNO DI PUTZU IDU (SALINA MANNA E PAULI MARIGOSA)	10	5	50.0
ITB030080	ISOLA DI MAL DI VENTRE E CATALANO	18	5	27.8
ITB032229	IS ARENAS S'ACQUA E S'OLLASTU	7	5	71.4
ITB042218	STAGNO DI PISCINNÌ	8	5	62.5
ITB042220	SERRA IS TRES PORTUS (SANT'ANTIOCO)	7	5	71.4
IT51A0028	DUNA DI FENIGLIA	13	4	30.8
IT6010018	LITORALE A NORD OVEST DELLE FOCI DEL FIORA	12	4	33.3
IT6010027	LITORALE TRA TARQUINIA E MONTALTO DI CASTRO	11	4	36.4
IT9150015	LITORALE DI GALLIPOLI E ISOLA S. ANDREA	18	4	22.2
IT9310304	ALTO IONIO COSENTINO	381	4	1.0
ITA030044	ARCIPELAGO DELLE EOLIE - AREA MARINA E TERRESTRE	197	4	2.0
ITA090027	FONDALI DI VENDICARI	10	4	40.0
ITB040028	PUNTA S'ALIGA	11	4	36.4
ITB042223	STAGNO DI SANTA CATERINA	11	4	36.4
ITB042225	IS PRUINIS	6	4	66.7
IT5160006	ISOLA DI CAPRAIA	33	3	9.1
IT5160007	ISOLA DI CAPRAIA - AREA TERRESTRE E MARINA	32	3	9.4
IT5160009	PROMONTORIO DI PIOMBINO E MONTE MASSONCELLO	16	3	18.8
IT51A0011	PADULE DI DIACCIA BOTRONA	24	3	12.5
IT51A0012	TOMBOLO DA CASTIGLION DELLA PESCAIA A MARINA DI GROSSETO	16	3	18.8
IT51A0013	PADULE DELLA TRAPPOLA, BOCCA D'OMBRONE	11	3	27.3
IT51A0016	MONTI DELL'UCCELLINA	65	3	4.6
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0031	LAGO DI BURANO	7	3	42.9
IT51A0033	LAGO DI BURANO	12	3	25.0
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	3	0.4
IT9110037	LAGHI DI LESINA E VARANO	212	3	1.4
IT9140002	LITORALE BRINDISINO	18	3	16.7
IT9150009	LITORALE DI UGENTO	27	3	11.1
IT9320104	COLLINE DI CROTONE	12	3	25.0
ITA020001	ROCCA DI CEFALÙ	3	3	100.0
ITA020002	BOSCHI DI GIBILMANNA E CEFALÙ	44	3	6.8
ITA020014	MONTE PELLEGRINO	15	3	20.0
ITA090014	SALINE DI AUGUSTA	3	3	100.0
ITB030037	STAGNO DI SANTA GIUSTA	20	3	15.0
ITB040018	FOCE DEL FLUMENDOSA - SA PRAIA	13	3	23.1
ITB042208	TRA POGGIO LA SALINA E PUNTA MAGGIORE	3	3	100.0
ITB042210	PUNTA GIUNCHERA	3	3	100.0
IT51A0008	MONTE D'ALMA	79	2	2.5

Code	Name	PA cells	PSA cells	Perc. PSA
IT51A0014	PINETA GRANDUCALE DELL'UCCELLINA	13	2	15.4
IT51A0032	DUNA DEL LAGO DI BURANO	7	2	28.6
IT51A0036	PIANURE DEL PARCO DELLA MAREMMA	61	2	3.3
IT6010019	PIAN DEI CANGANI	4	2	50.0
IT9110016	PINETA MARZINI	18	2	11.1
IT9150002	COSTA OTRANTO - SANTA MARIA DI LEUCA	74	2	2.7
IT9150006	RAUCCIO	12	2	16.7
IT9150008	MONTAGNA SPACCATA E RUPI DI SAN MAURO	9	2	22.2
IT9150013	PALUDE DEL CAPITANO	4	2	50.0
IT9150032	LE CESINE	19	2	10.5
IT9310042	FIUMARA SARACENO	27	2	7.4
IT9310043	FIUMARA AVENA	22	2	9.1
IT9320097	FONDALI DA CROTONE A LE CASTELLA	5	2	40.0
IT9320101	CAPO COLONNE	3	2	66.7
IT9320102	DUNE DI SOVERETO	6	2	33.3
IT9320106	STECCATO DI CUTRO E COSTA DEL TURCHESE	16	2	12.5
ITA030023	ISOLA DI ALICUDI	8	2	25.0
ITA030031	ISOLA BELLA, CAPO TAORMINA E CAPO S. ANDREA	2	2	100.0
ITA030033	CAPO CALAVÀ	6	2	33.3
ITA030040	FONDALI DI TAORMINA - ISOLA BELLA	3	2	66.7
ITA040004	FOCE DEL FIUME VERDURA	28	2	7.1
ITA040012	FONDALI DI CAPO SAN MARCO - SCIACCA	11	2	18.2
ITA050008	RUPE DI FALCONARA	5	2	40.0
ITA070003	LA GURNA	4	2	50.0
ITA080001	FOCE DEL FIUME IRMINO	6	2	33.3
ITA090013	SALINE DI PRIOLO	3	2	66.7
ITB040019	STAGNI DI COLOSTRAI E DELLE SALINE	19	2	10.5
ITB042216	SA TANCA E SA MURA - FOXI DURCI	2	2	100.0
IT51A0006	PADULE DI SCARLINO	5	1	20.0
IT51A0015	DUNE COSTIERE DEL PARCO DELL'UCCELLINA	10	1	10.0
IT6010026	SALINE DI TARQUINIA	6	1	16.7
IT6030019	MACCHIATONDA	6	1	16.7
IT6030020	TORRE FLAVIA	3	1	33.3
IT6040015	PARCO NAZIONALE DEL CIRCEO	151	1	0.7
IT6040016	PROMONTORIO DEL CIRCEO (QUARTO CALDO)	12	1	8.3
IT6040017	PROMONTORIO DEL CIRCEO (QUARTO FREDDO)	14	1	7.1
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
IT8050036	PARCO MARINO DI S. MARIA DI CASTELLABATE	21	1	4.8
IT8050048	COSTA TRA PUNTA TRESINO E LE RIPE ROSSE	54	1	1.9
IT9110008	VALLONI E STEPPE PEDEGARGANICHE	362	1	0.3
IT9110025	MANACORE DEL GARGANO	32	1	3.1
IT9110039	PROMONTORIO DEL GARGANO	874	1	0.1

Code	Name	PA cells	PSA cells	Perc. PSA
IT9120011	VALLE OFANTO - LAGO DI CAPACIOTTI	192	1	0.5
IT9130001	TORRE COLIMENA	31	1	3.2
IT9130002	MASSERIA TORRE BIANCA	18	1	5.6
IT9140005	TORRE GUACETO E MACCHIA S. GIOVANNI	11	1	9.1
IT9140008	TORRE GUACETO	8	1	12.5
IT9140009	FOCE CANALE GIANCOLA	5	1	20.0
IT9150007	TORRE ULUZZO	12	1	8.3
IT9150014	LE CESINE	14	1	7.1
IT9150022	PALUDE DEI TAMARI	1	1	100.0
IT9150024	TORRE INSERRAGLIO	5	1	20.0
IT9220080	COSTA IONICA FOCE AGRI	17	1	5.9
IT9220090	COSTA IONICA FOCE BRADANO	14	1	7.1
IT9320100	DUNE DI MARINELLA	2	1	50.0
ITA030018	PIZZO MICHELE	36	1	2.8
ITA030027	ISOLA DI VULCANO	33	1	3.0
ITA030029	ISOLA DI SALINA (STAGNO DI LINGUA)	20	1	5.0
ITA040009	MONTE SAN CALOGERO (SCIACCA)	3	1	33.3
ITA070002	RISERVA NATURALE FIUME FIUMEFREDDO	3	1	33.3
ITA070006	ISOLE DEI CICLOPI	2	1	50.0
ITA080004	PUNTA BRACCETTO, CONTRADA CAMMARANA	18	1	5.6
ITA090005	PANTANO DI MARZAMEMI	2	1	50.0
ITB010007	CAPO TESTA	12	1	8.3
ITB010009	CAPO FIGARI E ISOLA FIGAROLO	13	1	7.7
ITB010010	ISOLE TAVOLARA, MOLARA E MOLAROTTO	50	1	2.0
ITB013018	CAPO FIGARI, CALA SABINA, PUNTA CANIGIONE E ISOLA FIGAROLO	20	1	5.0
ITB032239	SAN GIOVANNI DI SINIS	1	1	100.0
ITB042209	A NORD DI SA SALINA (CALASETTA)	1	1	100.0
ITB042230	PORTO CAMPANA	5	1	20.0
	ITALY TOTAL:	12549	1878	15.0
PORTUGAL				
PTCON0011	ESTUÁRIO DO SADO	347	56	16.1
PTCON0013	RIA FORMOSA/CASTRO MARIM	249	50	20.1
PTZPE0011	ESTUÁRIO DO SADO	268	44	16.4
PTZPE0017	RIA FORMOSA	208	44	21.2
PTCON0010	ARRÁBIDA/ESPICHEL	199	34	17.1
PTCON0012	COSTA SUDOESTE	1181	29	2.5
PTCON0034	COMPORTA/GALÉ	415	27	6.5
PTZPE0004	RIA DE AVEIRO	425	24	5.6
PTCON0055	DUNAS DE MIRA, GÂNDARA E GAFANHAS	262	19	7.3
PTZPE0015	COSTA SUDOESTE	631	18	2.9
PTCON0017	LITORAL NORTE	71	10	14.1

Code	Name	PA cells	PSA cells	Perc. PSA
PTCON0009	ESTUÁRIO DO TEJO	385	8	2.1
PTZPE0010	ESTUÁRIO DO TEJO	395	8	2.0
PTZPE0013	LAGOA DE SANTO ANDRÉ	25	6	24.0
PTCON0008	SINTRA/CASCAIS	174	5	2.9
PTZPE0014	LAGOA DA SANCHA	5	4	80.0
PTZPE0050	CABO ESPICHEL	21	4	19.0
PTZPE0018	SAPAIS DE CASTRO MARIM	34	3	8.8
PTCON0018	BARRINHA DE ESMORIZ	10	2	20.0
PTCON0056	PENICHE / Stª CRUZ	91	1	1.1
	PORTUGAL TOTAL:	5396	396	7.3
	OVERALL NATURA 2000 TOTAL:	35568	5292	14.9

Table C.15: *Helianthemum caput-felis* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES000008	CAP ENDERROCAT-CAP BLANC	80	70	87.5	50	62.5
ES000008	SES SALINES D'EIVISSA I FORMENTERA	76	76	100.0	47	61.8
ES000008	ARXIPÈLAG DE CABRERA	75	75	100.0	42	56.0
ES000022	CAP DE SES SALINES	60	60	100.0	37	61.7
ES000026	MAR MENOR	67	67	100.0	37	55.2
ES620000	CALBLANQUE, MONTE DE LAS CENIZAS Y PEÑA DEL ÁGUILA	52	52	100.0	35	67.3
ES531010	ES AMUNTS D'EIVISSA	36	33	91.7	33	91.7
ES531003	CAP LLENTRISCA-SA TALAIA	50	50	100.0	32	64.0
ES620000	ESPACIOS ABIERTOS E ISLAS DEL MAR MENOR	40	40	100.0	26	65.0
ES531011	NORD DE SANT JOAN	26	26	100.0	22	84.6
ES000003	ES TRENC-SALOBRAR DE CAMPOS	26	26	100.0	17	65.4
ES000024	COSTA DELS AMUNTS	21	17	81.0	17	81.0
ES531002	LA MOLA	27	27	100.0	17	63.0
ES620002	SIERRA DE LA FAUSILLA	21	21	100.0	16	76.2
ES620003	MAR MENOR	45	45	100.0	16	35.6
ES000019	SIERRA DE LA FAUSILLA	20	20	100.0	15	75.0
ES531003	XARRACA	19	14	73.7	14	73.7
ES000017	SALINAS Y ARENALES DE SAN PEDRO DEL PINATAR	17	17	100.0	12	70.6
ES000026	SIERRA DE LA MUELA Y CABO TIÑOSO	147	17	11.6	12	8.2
ES531003	COSTA DE LLEVANT	28	28	100.0	12	42.9
ES531009	CALES DE MANACOR	16	16	100.0	12	75.0
ES620002	CABEZO DE ROLDÁN	22	17	77.3	12	54.5
ES000014	MONDRAGÓ	15	15	100.0	11	73.3
ES531010	COSTA DE L'OEST D'EIVISSA	26	26	100.0	11	42.3
ES620002	FRANJA LITORAL SUMERGIDA DE LA REGIÓN DE MURCIA	70	30	42.9	11	15.7
ES000045	IFAC I LITORAL DE LA MARINA	14	12	85.7	10	71.4
ES521100	IFAC	14	12	85.7	10	71.4
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES531002	CAP DE BARBARIA	18	18	100.0	10	55.6
ES531011	ÀREA MARINA PLATJA DE MIGJORN	22	22	100.0	9	40.9
ES521303	CABO ROIG	11	11	100.0	7	63.6
ES521201	SIERRA DE ESCALONA Y DEHESA DE CAMPOAMOR	77	6	7.8	6	7.8
ES531010	ÀREA MARINA DE TAGOMAGO	6	6	100.0	5	83.3

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ES000007	ES VEDRÀ-ES VEDRANELL	6	6	100.0	4	66.7
ES000046	SIERRA ESCALONA Y DEHESA DE CAMPOAMOR	136	4	2.9	4	2.9
ES521301	PENYA-SEGATS DE LA MARINA	31	5	16.1	4	12.9
ES000008	TAGOMAGO	3	3	100.0	3	100.0
ES531003	PORROIG	3	3	100.0	3	100.0
ES531003	SERRA GROSSA	25	25	100.0	3	12.0
ES531009	PORTOCOLOM	5	5	100.0	3	60.0
ES531010	ÀREA MARINA DE CALA SAONA	4	4	100.0	3	75.0
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES531010	ÀREA MARINA DEL CAP MARTINET	7	7	100.0	2	28.6
ES632000	ZONA MARÍTIMO TERRESTRE DE LOS ACANTILADOS DE AGUADÚ	2	2	100.0	2	100.0
ES632000	BARRANCO DEL NANO	4	2	50.0	2	50.0
ES000005	LLACUNES DE LA MATA I TORREVIEJA.	60	1	1.7	1	1.7
ES531003	BASSES DE LA MARINA DE LLUCMAJOR	3	3	100.0	1	33.3
ES531005	COVA D'EN BESSÓ	1	1	100.0	1	100.0
ES531005	COVA DES PIRATA	1	1	100.0	1	100.0
ES531005	COVA DES PONT	1	1	100.0	1	100.0
ES531010	PUNTA DES RAS	2	2	100.0	1	50.0
ES531012	BASSA DE FORMENTERA	1	1	100.0	1	100.0
ES620004	MEDIO MARINO	15	5	33.3	1	6.7
ES000020	ISLA GROSA	1	1	100.0	0	0.0
ES000021	ILLOTS DE TABARCA	12	5	41.7	0	0.0
ES000024	ILLOTS DE SANTA EULÀRIA, RODONA I ES CANÀ	2	2	100.0	0	0.0
ES000025	ISLAS HORMIGAS	1	1	100.0	0	0.0
ES521302	TABARCA	24	5	20.8	0	0.0
ES531004	COVA DELS ASES	1	1	100.0	0	0.0
ES531004	COVA DE SA GUITARRETA	1	1	100.0	0	0.0
ES531004	COVA DES PAS DE VALLGORNERA	1	1	100.0	0	0.0
ES531006	COVA NOVA DE SON LLUÍS	1	1	100.0	0	0.0
ES531011	ÀREA MARINA PLATJA DE TRAMUNTANA	1	1	100.0	0	0.0
ES620000	ISLAS E ISLOTES DEL LITORAL MEDITERRÁNEO	4	1	25.0	0	0.0
	SPAIN TOTAL:	1618	1088	67.2	676	41.8
ITALY						
ITB03003	STAGNO DI PUTZU IDU (SALINA MANNA E PAULI MARIGOSA)	10	4	40.0	2	20.0
ITB03003	ISOLA MAL DI VENTRE	6	6	100.0	0	0.0
ITB03008	ISOLA DI MAL DI VENTRE E CATALANO	18	9	50.0	0	0.0
	ITALY TOTAL:	34	19	55.9	2	5.9

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
	OVERALL NATURA 2000 TOTAL:	1652	1107	67.0	678	41.0

Table C.16: *Helianthemum caput-felis* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
26620	UNESCO-MAB Biosphere Reserve	El Kala	897	31	3.5
9741	National Park	El Kala	897	31	3.5
14909	Marine Park	El Kala	897	31	3.5
9758	Nature Reserve	Macta	207	18	8.7
14904	Breeding Station	Boumerdes	100	15	15.0
900574	Wetlands of International Importance (Ramsar)	Complexe de zones humides de la plaine de Guerbes-Sanhadja	432	4	0.9
72355	National Park	Edough	36	2	5.6
72362	National Park	Tigzirt	3	2	66.7
902531	UNESCO-MAB Biosphere Reserve	Gouraya	18	1	5.6
9747	National Park	Gouraya	18	1	5.6
9748	Regional Park	Seraidi P	40	1	2.5
72363	National Park	Tipaza Chenoua	49	1	2.0
		ALGERIA TOTAL:	3594	138	3.8
MOROCCO					
29969	National Park	Al Hoceima	271	55	20.3
20371	Marine Reserve	Bokkoyas	268	54	20.1
11698	Biological Reserve	Bokkoyas	268	54	20.1
902715	Wetlands of International Importance (Ramsar)	Sebkha Bou Areg	55	21	38.2
902704	Wetlands of International Importance (Ramsar)	Cap des Trois Fourches	26	17	65.4
15099	Nature Reserve	Nador	21	3	14.3
168216	UNESCO-MAB Biosphere Reserve	Arganeraie	20690	2	0.0
		MOROCCO TOTAL:	21599	206	1.0
TUNISIA					
903084	Wetlands of International Importance (Ramsar)	Sebkhet Kelbia	238	109	45.8
15185	Wetland Zone of National Importance	Sebkhet Kelbia	238	109	45.8
903080	Wetlands of International Importance (Ramsar)	Lagune de Ghar el Melh et DElta de la Mejerda	71	42	59.2
15188	Nature Reserve	Lac Bizerte	90	38	42.2
15182	Nature Reserve	Medjerda Estuary	66	36	54.5

Code	Type	Name	PA cells	PSA cells	Perc. PSA
32554	Wetland Zone of National Importance	Sebkhet Ariana	43	17	39.5
15194	Wetland Zone of National Importance	Sebkha Halk el Menzel	20	13	65.0
903087	Wetlands of International Importance (Ramsar)	Sebkhet Soliman	14	11	78.6
12390	National Park	Boukornine	24	9	37.5
903081	Wetlands of International Importance (Ramsar)	Lagunes du Cap Bon oriental	8	7	87.5
2115	UNESCO-MAB Biosphere Reserve	Iles Zembra et Zembretta	8	2	25.0
365017	Barcelona Convention	Zembra and Zembretta	8	2	25.0
942	National Park	Zembra and Zembretta	8	2	25.0
101847	Natural Reserve	Grotte de Chauve souris d'El Haouaria	1	1	100.0
15183	Wetland Zone of National Importance	Sebkhet es Sedjoumi	36	1	2.8
		TUNISIA TOTAL:	873	399	45.7
		OVERALL NORTH AFRICAN TOTAL:	26066	743	2.9

Table C.17: *Helianthemum caput-felis* EOO and AOO protection by North African protected areas

Code	Type	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
ALGERIA							
36501	Barcelona Convention	Iles Habibas	4	4	100.0	0	0.0
19571	Marine Nature Reserve	Iles Habibas	4	4	100.0	0	0.0
		ALGERIA TOTAL:	8	8	100.0	0	0.0
MOROCCO							
90270	Wetlands of International Importance (Ramsar)	Cap des Trois Fourches	26	11	42.3	6	23.1
		MOROCCO TOTAL:	26	11	42.3	6	23.1
		OVERALL NORTH AFRICAN TOTAL:	34	19	55.9	6	17.6

Medicago citrina

Table C.18: *Medicago citrina* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000023	L'ALBUFERA	255	62	24.3
ES0000471	L'ALBUFERA	255	62	24.3
ES0000020	DELTA DE L'EBRE	223	37	16.6
ES0000083	ARXIPÈLAG DE CABRERA	75	34	45.3
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	29	38.2
ES0000081	CAP ENDERROCAT-CAP BLANC	80	28	35.0
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	17	50.0
ES0000073	COSTA BRAVA DE MALLORCA	143	16	11.2
ES0000231	DELS ALOCS A FORNELLS	52	16	30.8
ES0000241	COSTA DELS AMUNTS	21	16	76.2
ES5310105	ES AMUNTS D'EIVISSA	36	15	41.7
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	13	40.6
ES5223007	MARJAL D'ALMENARA	32	13	40.6
ES5310032	CAP LLENTRISCA-SA TALAIA	50	13	26.0
ES5310112	NORD DE SANT JOAN	26	13	50.0
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	12	44.4
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES5211009	IFAC	14	12	85.7
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	12	48.0
ES5222005	MARJAL DE NULES	19	12	63.2
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES0000074	CAP DE CALA FIGUERA	20	11	55.0
ES0000227	MUNTANYES D'ARTÀ	129	11	8.5
ES0000228	CAP DE SES SALINES	60	11	18.3
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	10	6.7
ES5213018	PENYA-SEGATS DE LA MARINA	31	10	32.3
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310104	COSTA DE L'OEST D'EIVISSA	26	10	38.5
ES5233030	MARJAL DE LA SAFOR	24	9	37.5
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	9	18.0
ES5310024	LA MOLA	27	9	33.3
ES5310033	XARRACA	19	9	47.4
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	8	30.8
ES0000229	COSTA NORD DE CIUTADELLA	17	8	47.1

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000148	MARJAL DELS MOROS.	15	7	46.7
ES0000470	MARJAL DELS MOROS	15	7	46.7
ES5310025	CAP DE BARBARIA	18	7	38.9
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	7	30.4
ES0000221	SA DRAGONERA	15	6	40.0
ES0000230	LA VALL	74	6	8.1
ES0000237	DES CANUTELLS A LLUCALARI	45	6	13.3
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	6	15.0
ES5211007	MONTGÓ	40	6	15.0
ES5310068	CAP NEGRE	9	6	66.7
ES5310113	LA VALL	46	6	13.0
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	5	27.8
ES0000120	SALINAS DE SANTA POLA.	44	5	11.4
ES0000238	SON BOU I BARRANC DE SA VALL	29	5	17.2
ES0000467	PRAT DE CABANES I TORREBLANCA	18	5	27.8
ES5310074	DE CALA LLUCALARI A CALES COVES	12	5	41.7
ES5310081	PORT DES CANONGE	14	5	35.7
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	5	38.5
ES5310098	CALES DE MANACOR	16	5	31.2
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES0000038	S'ALBUFERA DE MALLORCA	39	4	10.3
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000453	MUNTANYES DE LA MARINA	557	4	0.7
ES5213020	SERRES DEL FERRER I BÈRNIA	57	4	7.0
ES5213024	TABARCA	24	4	16.7
ES5213032	CAP DE LES HORTES	15	4	26.7
ES5310029	NA BORGES	69	4	5.8
ES0000082	TAGOMAGO	3	3	100.0
ES0000145	MONDRAGÓ	15	3	20.0
ES0000223	SA FORADADA	5	3	60.0
ES0000226	L'ALBUFERETA	10	3	30.0
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	3	10.3
ES0000235	DE S'ALBUFERA A LA MOLA	41	3	7.3
ES0000462	CLOT DE GALVANY	12	3	25.0
ES5222002	MARJAL DE PENÍSCOLA	5	3	60.0
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5232007	RIU XÚQUER	74	3	4.1
ES5310076	SERRAL D'EN SALAT	6	3	50.0
ES5310096	PUNTA DE N'AMER	6	3	50.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES0000061	ILLES COLUMBRETES	4	2	50.0
ES0000079	LA VICTÒRIA	16	2	12.5
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	2	13.3

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000222	LA TRAPA	10	2	20.0
ES0000224	MULETA	7	2	28.6
ES0000444	SERRA D'IRTA	105	2	1.9
ES5223036	SERRA D'IRTA	105	2	1.9
ES5310087	BÀLITX	12	2	16.7
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES0000080	CAP VERMELL	6	1	16.7
ES0000214	ILLOTS DE TABARCA	12	1	8.3
ES0000225	SA COSTERA	14	1	7.1
ES0000233	D'ADDAIA A S'ALBUFERA	35	1	2.9
ES0000239	DE BINIGAUS A CALA MITJANA	48	1	2.1
ES5140001	LITORAL MERIDIONAL TARRAGONÍ	20	1	5.0
ES5140022	BARRANC DE SANTES CREUS	9	1	11.1
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5310008	ES GALATZÓ-S'ESCLOP	36	1	2.8
ES5310031	PORROIG	3	1	33.3
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	1	5.0
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	1	10.0
ES5310084	TORRE PICADA	5	1	20.0
ES5310095	CAN PICAFORT	3	1	33.3
ES5310099	PORTOCOLOM	5	1	20.0
ES5310100	PUNTA DES RAS	2	1	50.0
	SPAIN TOTAL:	4134	810	19.6
	OVERALL NATURA 2000 TOTAL:	4134	810	19.6

Table C.19: *Medicago citrina* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES000024	COSTA DELS AMUNTS	21	21	100.0	16	76.2
ES531010	ES AMUNTS D'EIVISSA	36	36	100.0	15	41.7
ES531011	NORD DE SANT JOAN	26	26	100.0	13	50.0
ES531003	CAP LLENTRISCA-SA TALAIA	50	45	90.0	12	24.0
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES531010	COSTA DE L'OEST D'EIVISSA	26	22	84.6	10	38.5
ES531003	XARRACA	19	19	100.0	9	47.4
ES000008	ARXIPÈLAG DE CABRERA	75	15	20.0	7	9.3
ES531010	ÀREA MARINA DE TAGOMAGO	6	6	100.0	5	83.3
ES000008	TAGOMAGO	3	3	100.0	3	100.0
ES000006	ILLES COLUMBRETES	4	4	100.0	2	50.0
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES531010	ÀREA MARINA DEL CAP MARTINET	7	7	100.0	2	28.6
ES000007	ES VEDRÀ-ES VEDRANELL	6	2	33.3	1	16.7
ES000008	SES SALINES D'EIVISSA I FORMENTERA	76	2	2.6	1	1.3
ES000045	MONTGÓ-CAP DE SANT ANTONI	40	1	2.5	1	2.5
ES521100	MONTGÓ	40	1	2.5	1	2.5
ES531003	PORROIG	3	2	66.7	1	33.3
ES000024	ILLOTS DE SANTA EULÀRIA, RODONA I ES CANÀ	2	2	100.0	0	0.0
ES531003	SERRA GROSSA	25	25	100.0	0	0.0
	SPAIN TOTAL:	480	254	52.9	111	23.1
	OVERALL NATURA 2000 TOTAL:	480	254	52.9	111	23.1

Silene hifacensis

Table C.20: *Silene hifacensis* PSA protection by Natura 2000 protected areas

Code	Name	PA cells	PSA cells	Perc. PSA
SPAIN				
ES0000023	L'ALBUFERA	255	74	29.0
ES0000471	L'ALBUFERA	255	74	29.0
ES0000081	CAP ENDERROCAT-CAP BLANC	80	61	76.2
ES0000073	COSTA BRAVA DE MALLORCA	143	56	39.2
ES0000084	SES SALINES D'EIVISSA I FORMENTERA	76	46	60.5
ES0000227	MUNTANYES D'ARTÀ	129	43	33.3
ES0000231	DELS ALOCS A FORNELLS	52	43	82.7
ES0000083	ARXIPÈLAG DE CABRERA	75	42	56.0
ES0000228	CAP DE SES SALINES	60	40	66.7
ES5310032	CAP LLENTRISCA-SA TALAIA	50	38	76.0
ES5310105	ES AMUNTS D'EIVISSA	36	33	91.7
ES0000451	MONTDÚVER-MARJAL DE LA SAFOR	149	25	16.8
ES5310035	ÀREA MARINA DEL NORD DE MENORCA	34	25	73.5
ES0000230	LA VALL	74	24	32.4
ES0000237	DES CANUTELLS A LLUCALARI	45	24	53.3
ES5233030	MARJAL DE LA SAFOR	24	23	95.8
ES5310112	NORD DE SANT JOAN	26	23	88.5
ES5310113	LA VALL	46	23	50.0
ES0000038	S'ALBUFERA DE MALLORCA	39	22	56.4
ES0000241	COSTA DELS AMUNTS	21	20	95.2
ES5213018	PENYA-SEGATS DE LA MARINA	31	20	64.5
ES5310005	BADIES DE POLLENÇA I ALCÚDIA	50	20	40.0
ES0000454	MONTGÓ-CAP DE SANT ANTONI	40	19	47.5
ES5211007	MONTGÓ	40	19	47.5
ES0000121	ILLOTS DE BENIDORM I SERRA GELADA	27	18	66.7
ES0000037	ES TRENC-SALOBRAR DE CAMPOS	26	17	65.4
ES0000233	D'ADDAIA A S'ALBUFERA	35	17	48.6
ES0000235	DE S'ALBUFERA A LA MOLA	41	17	41.5
ES5310024	LA MOLA	27	17	63.0
ES5213021	SERRA GELADA I LITORAL DE LA MARINA BAIXA	25	16	64.0
ES5310033	XARRACA	19	16	84.2
ES0000074	CAP DE CALA FIGUERA	20	14	70.0
ES0000147	MARJAL DE PEGO-OLIVA.	24	14	58.3
ES0000229	COSTA NORD DE CIUTADELLA	17	14	82.4
ES0000239	DE BINIGAUS A CALA MITJANA	48	14	29.2

Code	Name	PA cells	PSA cells	Perc. PSA
ES0000443	SUD DE CIUTADELLA	38	14	36.8
ES0000145	MONDRAGÓ	15	13	86.7
ES0000232	LA MOLA I S'ALBUFERA DE FORNELLS	29	13	44.8
ES0000238	SON BOU I BARRANC DE SA VALL	29	13	44.8
ES5310029	NA BORGES	69	13	18.8
ES0000240	COSTA SUD DE CIUTADELLA	25	12	48.0
ES0000453	MUNTANYES DE LA MARINA	557	12	2.2
ES0000459	IFAC I LITORAL DE LA MARINA	14	12	85.7
ES5211009	IFAC	14	12	85.7
ES5310030	COSTA DE LLEVANT	28	12	42.9
ES5310098	CALES DE MANACOR	16	12	75.0
ES0000079	LA VICTÒRIA	16	11	68.8
ES0000234	S'ALBUFERA DES GRAU	31	11	35.5
ES0000450	MARJAL I ESTANYS D'ALMENARA	32	11	34.4
ES5223007	MARJAL D'ALMENARA	32	11	34.4
ES5310104	COSTA DE L'OEST D'EIVISSA	26	11	42.3
ES5310023	ILLOTS DE PONENT D'EIVISSA	13	10	76.9
ES5310025	CAP DE BARBARIA	18	10	55.6
ES0000148	MARJAL DELS MOROS.	15	9	60.0
ES0000226	L'ALBUFERETA	10	9	90.0
ES0000470	MARJAL DELS MOROS	15	9	60.0
ES5222005	MARJAL DE NULES	19	9	47.4
ES5310068	CAP NEGRE	9	9	100.0
ES5310111	ÀREA MARINA PLATJA DE MIGJORN	22	9	40.9
ES5213020	SERRES DEL FERRER I BÈRNIA	57	8	14.0
ES5310078	DE CALA DE SES ORTIGUES A CALA ESTELLENCS	23	8	34.8
ES5310081	PORT DES CANONGE	14	8	57.1
ES5310074	DE CALA LLUCALARI A CALES COVES	12	7	58.3
ES0000221	SA DRAGONERA	15	6	40.0
ES5310082	S'ESTACA-PUNTA DE DEIÀ	13	6	46.2
ES5310093	FORMENTOR	7	6	85.7
ES0000222	LA TRAPA	10	5	50.0
ES5232007	RIU XÚQUER	74	5	6.8
ES5310015	PUIG DE SANT MARTÍ	6	5	83.3
ES5310076	SERRAL D'EN SALAT	6	5	83.3
ES5310107	ÀREA MARINA DE TAGOMAGO	6	5	83.3
ES0000020	DELTA DE L'EBRE	223	4	1.8
ES0000060	PRAT DE CABANES I TORREBLANCA.	18	4	22.2
ES0000078	ES VEDRÀ-ES VEDRANELL	6	4	66.7
ES0000223	SA FORADADA	5	4	80.0
ES0000467	PRAT DE CABANES I TORREBLANCA	18	4	22.2
ES5213032	CAP DE LES HORTES	15	4	26.7
ES5213042	VALLS DE LA MARINA	212	4	1.9

Code	Name	PA cells	PSA cells	Perc. PSA
ES5310034	SERRA GROSSA	25	4	16.0
ES5310036	ÀREA MARINA DEL SUD DE CIUTADELLA	20	4	20.0
ES5310070	PUNTA REDONA-ARENAL D'EN CASTELL	10	4	40.0
ES5310096	PUNTA DE N'AMER	6	4	66.7
ES0000080	CAP VERMELL	6	3	50.0
ES0000082	TAGOMAGO	3	3	100.0
ES0000120	SALINAS DE SANTA POLA.	44	3	6.8
ES0000224	MULETA	7	3	42.9
ES5222007	ALGUERS DE BORRIANA-NULES-MONCOFA	3	3	100.0
ES5310031	PORROIG	3	3	100.0
ES5310087	BÀLITX	12	3	25.0
ES5310099	PORTOCOLOM	5	3	60.0
ES5310109	ÀREA MARINA DE CALA SAONA	4	3	75.0
ES0000225	SA COSTERA	14	2	14.3
ES5222002	MARJAL DE PENÍSCOLA	5	2	40.0
ES5233015	SERRES DEL MONTDÚVER I MARXUQUERA	122	2	1.6
ES5310069	CALA D'ALGAIRENS	3	2	66.7
ES5310106	ÀREA MARINA DE SES MARGALIDES	2	2	100.0
ES5310108	ÀREA MARINA DEL CAP MARTINET	7	2	28.6
ES5310115	ES MOLINET	2	2	100.0
ES0000211	DESEMBOCADURA DEL RIU MILLARS	15	1	6.7
ES0000214	ILLOTS DE TABARCA	12	1	8.3
ES5213024	TABARCA	24	1	4.2
ES5222006	PLATJA DE MONCOFA	1	1	100.0
ES5233013	SERRA DE CORBERA	83	1	1.2
ES5310008	ES GALATZÓ-S'ESCLOP	36	1	2.8
ES5310037	BASSES DE LA MARINA DE LLUCMAJOR	3	1	33.3
ES5310050	COVA D'EN BESSÓ	1	1	100.0
ES5310055	COVA DES PIRATA	1	1	100.0
ES5310056	COVA DES PONT	1	1	100.0
ES5310057	COVA DE CAL PESSO	1	1	100.0
ES5310059	COVA DE LLENAIRE	1	1	100.0
ES5310072	CALETA DE BINILLAUTÍ	1	1	100.0
ES5310075	ARENAL DE SON SAURA	5	1	20.0
ES5310084	TORRE PICADA	5	1	20.0
ES5310095	CAN PICAFORT	3	1	33.3
ES5310100	PUNTA DES RAS	2	1	50.0
ES5310123	BASSA DE FORMENTERA	1	1	100.0
	SPAIN TOTAL:	4470	1455	32.6
FRANCE				
FR9400574	PORTO/SCANDOLA/REVELLATA/CALVI/CALANCHES DE PIANA (ZONE TERRESTRE ET MARINE)	202	37	18.3

Code	Name	PA cells	PSA cells	Perc. PSA
FR9410023	GOLFE DE PORTO ET PRESQU'ÎLE DE SCANDOLA	181	35	19.3
FR9301613	RADE D'HYERES	141	30	21.3
FR9310020	ILES D'HYÈRES	130	26	20.0
FR9312008	SALINS D'HYÈRES ET DES PESQUIERS	21	10	47.6
FR9402018	CAP ROSSU, SCANDOLA, POINTE DE LA REVELETTA, CANYON DE CALVI	25	6	24.0
FR9400572	MUCCHIATANA	9	5	55.6
FR9412010	CAPU ROSSU , SCANDOLA, REVELLATA, CALVI	40	4	10.0
FR9400617	DUNES DE PRUNETE-CANNICCIA	4	3	75.0
FR9402014	GRAND HERBIER DE LA CÔTE ORIENTALE	8	2	25.0
FR9402017	GOLFE D'AJACCIO	66	2	3.0
FR9410096	ILES SANGUINAIRES, GOLFE D'AJACCIO	66	2	3.0
FR9301610	CAP SICIE - SIX FOURS	18	1	5.6
FR9400580	MARAIS DEL SALE, ZONES HUMIDES PERIPHERIQUES ET FORET LITTORALE DE PINIA	22	1	4.5
FR9400595	ILES SANGUINAIRES, PLAGE DE LAVA ET PUNTA PELLUSELLA	11	1	9.1
FR9400619	CAMPO DELL'ORO (AJACCIO)	3	1	33.3
FR9410098	URBINO	41	1	2.4
	FRANCE TOTAL:	988	167	16.9
ITALY				
IT51A0023	ISOLA DEL GIGLIO	34	13	38.2
IT51A0025	MONTE ARGENTARIO, ISOLOTTO DI PORTO ERCOLE E ARGENTAROLA	84	13	15.5
IT51A0024	ISOLA DI GIANNUTRI	10	3	30.0
IT51A0026	LAGUNA DI ORBETELLO	58	3	5.2
IT51A0037	ISOLA DI GIANNUTRI - AREA TERRESTRE E MARINA	10	3	30.0
IT6030005	COMPRENSORIO TOLFETANO-CERITE-MANZIATE	770	3	0.4
IT6010026	SALINE DI TARQUINIA	6	1	16.7
IT6040019	ISOLE DI PONZA, PALMAROLA, ZANNONE, VENTOTENE E S. STEFANO	41	1	2.4
	ITALY TOTAL:	1013	40	3.9
	OVERALL NATURA 2000 TOTAL:	6471	1662	25.7

Table C.21: *Silene hifacensis* EOO and AOO protection by Natura 2000 protected areas

Code	Name	PA cells	EOO cells	Perc. EOO	AOO cells	Perc. AOO
SPAIN						
ES531003	CAP LLENTRISCA-SA TALAIA	50	38	76.0	31	62.0
ES531010	ES AMUNTS D'EIVISSA	36	26	72.2	26	72.2
ES521301	PENYA-SEGATS DE LA MARINA	31	31	100.0	20	64.5
ES000024	COSTA DELS AMUNTS	21	18	85.7	18	85.7
ES000045	IFAC I LITORAL DE LA MARINA	14	13	92.9	12	85.7
ES521100	IFAC	14	13	92.9	12	85.7
ES531002	ILLOTS DE PONENT D'EIVISSA	13	13	100.0	10	76.9
ES531010	COSTA DE L'OEST D'EIVISSA	26	22	84.6	10	38.5
ES000007	ES VEDRÀ-ES VEDRANELL	6	5	83.3	4	66.7
ES531010	ÀREA MARINA DE SES MARGALIDES	2	2	100.0	2	100.0
ES000045	MONTGÓ-CAP DE SANT ANTONI	40	2	5.0	1	2.5
ES521100	MONTGÓ	40	2	5.0	1	2.5
ES521302	SERRES DEL FERRER I BÈRNIA	57	1	1.8	1	1.8
	SPAIN TOTAL:	350	186	53.1	148	42.3
	OVERALL NATURA 2000 TOTAL:	350	186	53.1	148	42.3

Table C.22: *Silene hifacensis* PSA protection by North African protected areas

Code	Type	Name	PA cells	PSA cells	Perc. PSA
ALGERIA					
72362	National Park	Tigzirt	3	2	66.7
		ALGERIA TOTAL:	3	2	66.7
		OVERALL NORTH AFRICAN TOTAL:	3	2	66.7

Appendix D

Occurrence maps of Invasive Alien Species

In each figure, grey larger squares represent species occurrences at 10 km resolution while smaller black squares represent species occurrences at 1 km resolution. All maps are in projection Universal Transverse Mercator, Datum ED50, zone 31N (EPSG: 23031, http://spatialreference.org/ref/epsg/23031/)

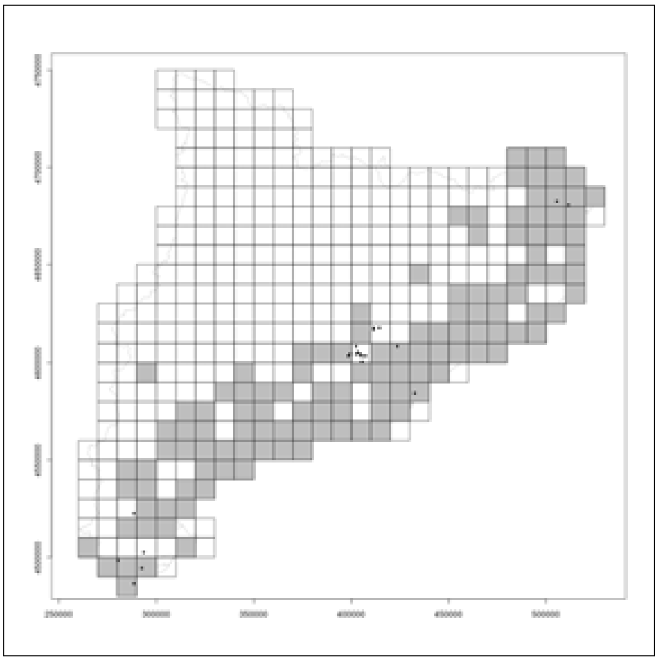


Figure D.1: *Agave americana*

Figure D.2: *Ailanthus altissima*

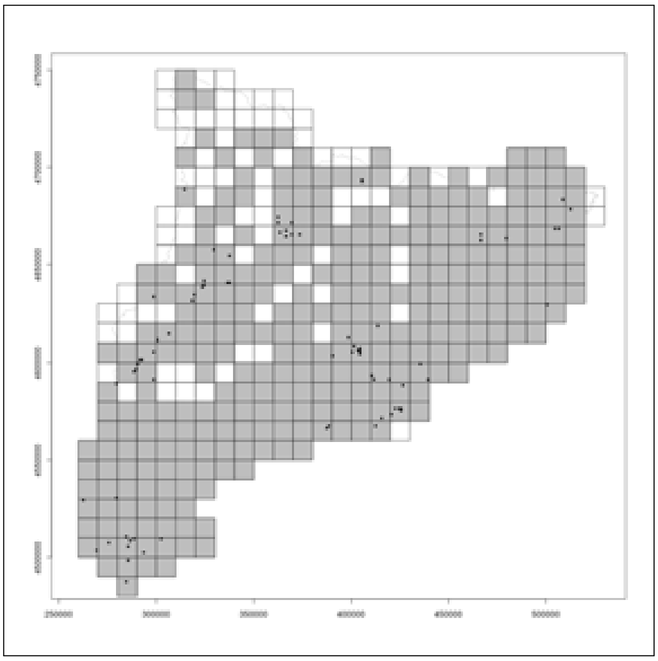


Figure D.3: *Conyza canadensis*

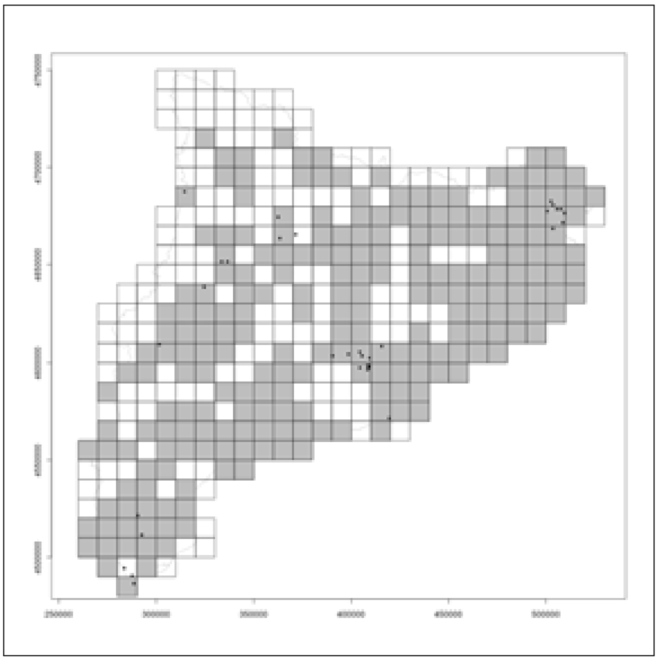


Figure D.4: *Datura stramonium*

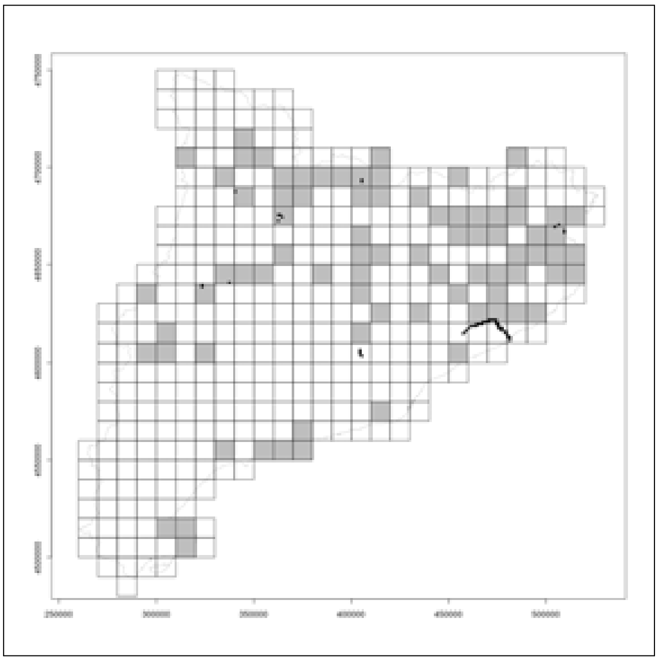


Figure D.5: *Oenothera biennis*

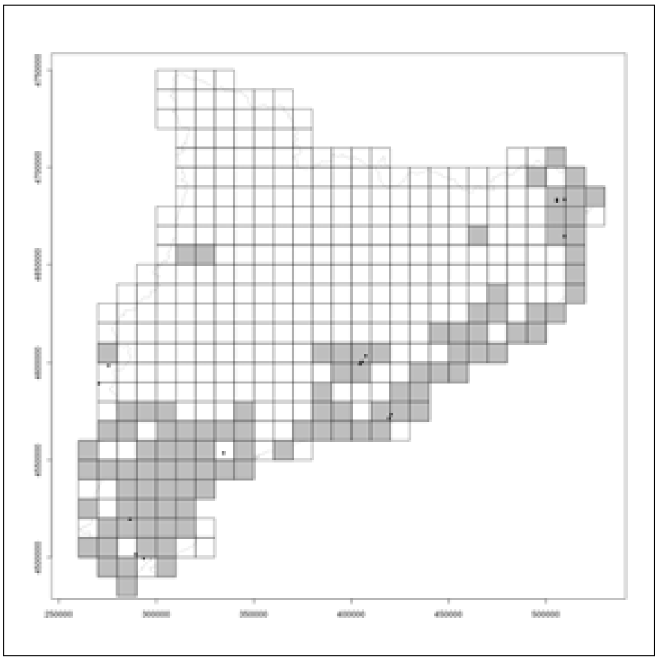


Figure D.6: *Opuntia ficus-indica*

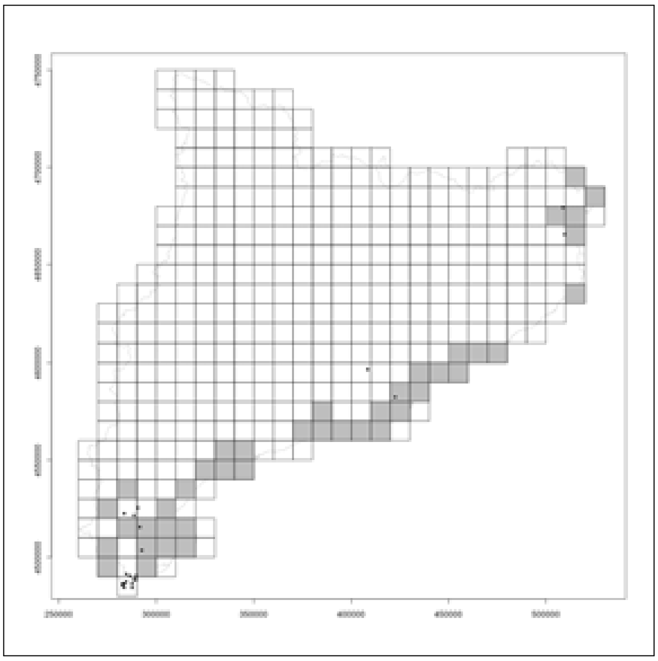


Figure D.7: *Oxalis pes-caprae*

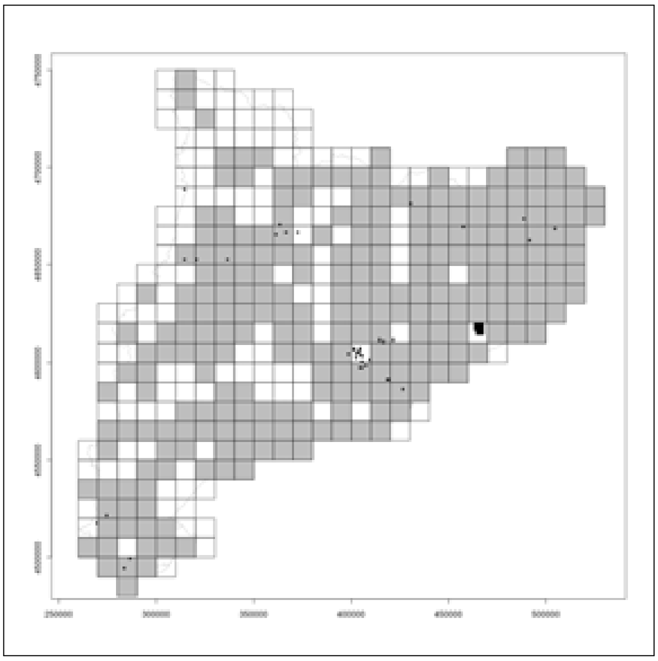


Figure D.8: *Robinia pseudoacacia*

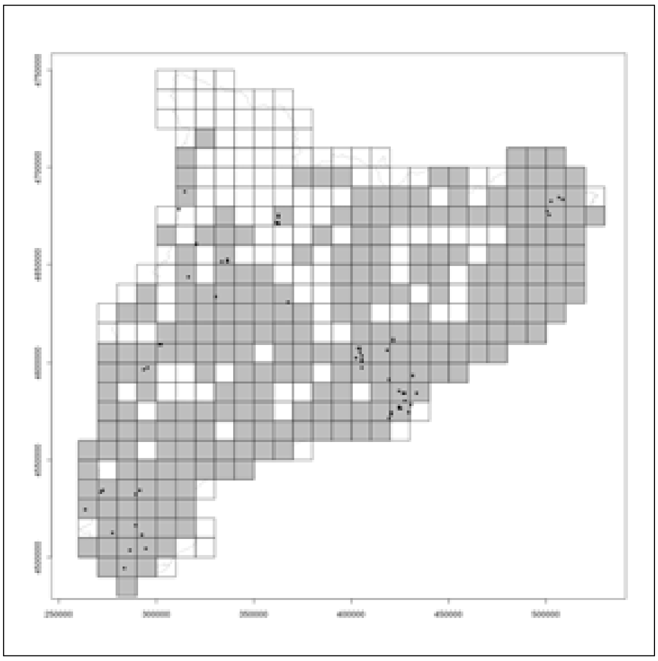


Figure D.9: *Xanthium spinosum*

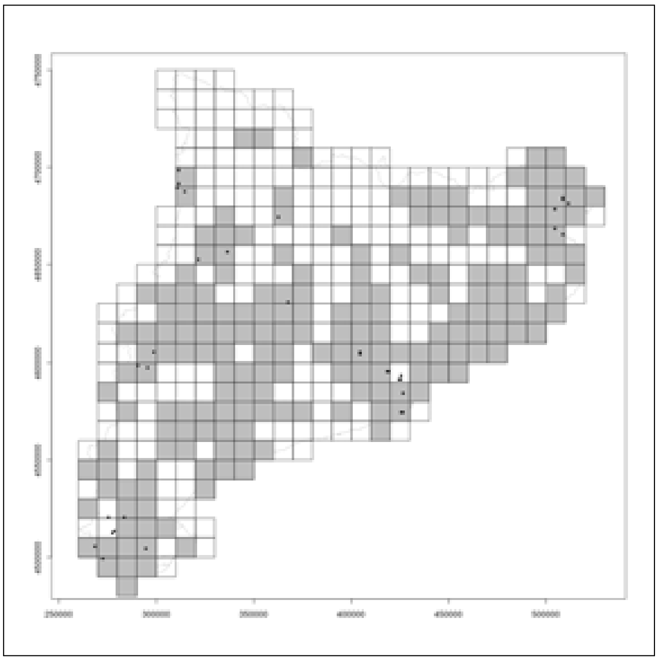


Figure D.10: *Amaranthus albus*