2. NETWORKS AND SYSTEMS OF NATURAL PROTECTED AREAS

2.1. Contributions made by the natural protected areas to the integrity of the ecosystems and to environmental health

We find the historical origin of natural protected areas in the social will to prevent the disappearance of exceptional places which are outstanding due to the grandeur of their landscapes, the richness or uniqueness of their fauna and flora, or their unspoiled state. The first national parks were conceived as isolated enclosures, separated from a surrounding territory which was undergoing dramatic transformation. The spirit of such parks stems from a romantic and nostalgic sensitivity to Nature born under the wing of enlightened positivism. Terms such as picturesque, rugged, natural beauty, unique location or remarkable spot, are a part of the terminology used to argue in favour of the conservation values of such places and they have been so recorded in moving legal documents concerning the establishment of the first national parks.

Classic conservationist theories were in tune with the belief in the immutable equilibrium of Nature (McIntosh, 1985). Accordingly, the purpose was no other than keeping places unaltered where wildlife could go on as usual away from hostile human presence. Up to the eighties, conservation - related issues were being dealt with in an insular frame of mind; in other words, what it all was about was isolating or defending the natural area from the destructive effects of man - made development. However, both this approach and its complementary conservationist strategy aimed at individual emblematic species have proven, to a great extent, to be unfeasible as well as inefficacious (Angenmeier and Karr, 1994). Current scientific knowledge has glaringly shown the inadequacy of the climax concept, the non - viability of the most mature places and the scarce revival power that these island - spaces can have with regard to the ecosystem (Holdgate, 1996). Indeed, conservation has been exclusively focused on taking care of singularity and of the most unspoiled ecosystems, paying no attention to the importance of species belonging to intermediate succession states. On the

other hand, one of the distinctive problems posed by the traditional approach to conservation is the isolation of populations, which actually prevents genetic exchange.

The model's limitations began to be taken into account from the eighties onwards, when greater integration was sought between protected natural areas and their surrounding environment. The concept of biosphere reserve with its peripheral **buffer zone** is inspired by this idea. It was during the aforesaid decade that the concept of conservation network came to have greater importance, by looking for a more efficacious way to achieve the goals of the protected areas. The European Habitat Directive (1992/43/EEC) does suggest the establishment of the Natura 2000 Network, taking as a starting point the identification and selection of habitats of a Community-wide interest. Generally speaking there are three purposes underlying the network philosophy:

1. To maintain the flow of populations between different natural protected areas.
2. To act as a showcase of the region's diversity of species and ecosystems, as a result of the singularities gathered in each natural protected space.
3. The network as a political project must be in keeping with a plan or a purpose set by the institution which has created it, by being consistent from the standpoints of the administration and the management.

In addition to the usual loss of biological diversity, the concept of nature conservation has evolved over the last few years under the influence of two scientific evidences:

- Natural and semi - natural ecosystems do provide society with goods and services which, should these ecosystems be non existent, would be very expensive to obtain. Such goods and services are invisible both to the nations' accounting systems and to the market.
- Our knowledge of the consequences of the climatic change does suggest that those species and ecosystems having a grater capability to adapt will play an important role in the conservation of future ecosystems.

Monumentality and admiration considerations which did infuse the creation of the first national parks into the 19th century conservationists, must nowadays be

supplemented by the confirmation of the fact that natural ecosystems do provide society with goods and services related to the regulation of life - supporting cycles and processes. Some of these processes are the hydrological cycle, the flow of energy and the trophic organization of the ecosystem; the biogeochemical cycles and the transfer of nutrients; the dynamics of the populations and the interaction among species; the ecological succession and the self - organization of ecosystems; the fluctuations and the natural disruption pattern; the processes of the dissemination of propagules and the migration of the species.

Among the goods and services deriving from the operation of natural ecosystems, the following can be highlighted: the regulation of the composition of atmospheric gases, as well as that of the climate and the hydrological cycle; the control of erosion, the formation of soil, the regulation of the cycles of nutrients, the pollination, the biological control of populations, the preservation of biological diversity, the storage and supply of water, the production of food and raw materials, as well as areas for the development of human habitat, not to mention leisure and culture (Cairns, 1996).

Some of these services can be locally identified and their benefits are also immediate and, sometimes, can be assessed in financial terms. By way of example, the growing touristical activity taking place around protected areas is the result of efforts made for the conservation of wild ecosystems which are attractive to visitors. Conversely, other goods and services only manifest themselves in very wide extensions and time scales, as it is the case of atmospheric gas regulation. It is evident that in order to get a good picture of the advantages gained from the preservation of natural ecosystems it is necessary to use local, regional and global approaches, taking also into consideration different time projections. Likewise, it seems to be clear that the conservation of these ecosystems is a necessity for the maintenance of social well - being.

Goods and services provided by the ecosystems, whether or not they do have a financial value for the market systems, are producing indispensable benefits to the economy, the public health and the general welfare of human beings (Daily, 1997). Healthy ecosystems constitute a natural capital, a minimum reserve of which needs to be maintained to guarantee its renewal on a permanent basis in order not to undercapitalise the society using it. Their sustainable exploitation means the current and potential supply of goods and services indispensable for the maintenance of the capital, social as well as human, built up by our society (Goodland and Daly, 1996).

The awareness of the uncertainty introduced by the observation of the climatic change is having an influence on the direction of conservation policies. The traditional idea, according to which the main objective of conservation is the keeping of places where human presence is reduced to a minimum, for they are redoubts of greater biological diversity, is no longer sufficient (Pérez-Corona et al, 2002). Semi - natural (i.e. managed) ecosystems can contain a large biodiversity consisting of species having a greater response capability to face the uncertainties of the future, than rare, relict or exceptional species posses. It is also known that ecological succession is accompanied by a biological diversity curve whose highest point does not usually occur in the greatest maturity situation, but, rather, in a previous situation with a certain degree of exploitation (Connell, 1978). The species belonging to the different intermediate stages in the development of an ecosystem are not the same as the ones we are going to find in the greatest maturity situations. Such knowledge does particularly apply to the management and planning of Mediterranean landscapes (Makhzoumi and Pungetti, 1999), where the lengthy process of joint evolution of culture and nature is responsible for the managed landscapes, which are compatible with high biological diversity values.

The most advanced approaches to nature conservation are no longer paying exclusive attention to the unspoiled ecosystems; they also bear in mind the environmental services provided by the semi - natural ecosystems. The objective is the keeping of optimal combinations of natural and semi - natural ecosystems and the urban artificial ecosystems, where a large part of society has its place of abode, in such a way that nature's environmental services be guaranteed. Within the territory, these different types of ecosystems do form a spatial combination giving birth to configurations which are perceived by society as landscapes. Landscape has been described as a mosaic of kilometric width consisting of local repeated ecosystems (Forman, 1995). Among the mosaic's patches functional processes are kept in place which have a close relationship, and horizontal flows among ecosystems. The landscape scale is a highly appropriate level to represent nature conservation networks or systems, in view of the functional component represented by such a scale.

In larger scales, the eco - regional environment is being increasingly used as a point of reference for the organization of conservation systems (Montes et al 1998). The eco - regions, being characterised by large - scale climatic and biogeographical similarities, have sets of characteristic species and ecosystems, whose state of conservation must be assessed within this territorial extension.

We can, therefore, say that the spatial frames of reference being the most appropriate in order to deal with the maintenance of the environmental services provided by the ecosystems are those of the landscape and the eco - region.

2.2. Reference points to assess the state of environmental services

Over the last few years different concepts have been coined for the purpose of describing this so - called optimal state of natural ecosystems which would make it possible to guarantee that society be provided with goods and services. Some of these concepts are an important point of reference for the definition of the objectives of a conservation network, which is the reason why they are in need of clarification.

Ecological integrity means the capability of an ecosystem to perpetuate its operation over time, by following its natural evolution path, as well as the capability to recover following a disturbance (Angermeier and Karr, 1994; Brown *et al.*, 2000). Integrity entails greater vigour (the system's overall capability to process matter and energy), a better organisation or efficaciousness in the transfer and degradation of energy as well as the capability to withstand disturbances (Westra *et al.*, 2000). An ecosystem with a higher level of *integrity* would be able to obtain more useful work out of solar energy than other with a lower level of *integrity* would in the same location (Ulanowicz, 2000). The state of maximal integrity would exclude human activities which dissipate energy and destroy the ecosystem's organization.

Ideally, the purpose of natural protected areas is that of preserving the integrity of the ecosystems as far as possible. Ecological integrity, as related to territories or regions, does include the representation of the full range of native species and ecological functions with their scope of natural variability, regardless of the local state of an ecosystem at any given time.

Ecological integrity is a state of reference which indicates the optimum for the assessment of the ecosystems. However, in the case of Mediterranean ecosystems the intention of achieving that maximal integrity is, probably, both naïve and undesirable. As a matter of fact, the value of many of these ecosystems precisely lies in the degree of adjustment achieved between the exploitation and the operation of the ecosystem. A large number of species which, in a primigenial

state would be a part of the integrous ecosystem have disappeared. Even taking all this into consideration, it is far from disdainable the intention of recovering, in some cases, a degree of maximal integrity by taking advantage of the tendency to abandon agricultural systems and forests which have a marginal use.

The health of an ecosystem consists in the ability that it has to maintain its structure and function over time against a certain degree of external stress (Costanza, 1992). It is not necessary that an ecosystem in good health be utterly integrous, for it admits a certain degree of exploitation. On a landscape scale, the health of the ecosystem would entail the keeping of the goods and services provided by all the elements of the mosaic. A landscape enjoying a good state of health is capable of providing environmental goods and services deriving from the ecosystems, natural as well as semi - natural and artificial, without its future being jeopardised by it. The different patches making up the landscape mosaic would provide benefits of a different nature: the wildest of the patches being oriented towards the services of the natural ecosystems; the patches being used by intensive agriculture, will be preferably aimed at extractive goals.

The concept of sustainability is closely linked with that of the health of the ecosystem, and reference would be made to viable projects or activities by keeping the ecosystem's health (Karr, 2000). The idea of sustainability does add a regulatory aspect concerning the decisions by the governing powers to incorporate environmental, financial and social goals into the development policy (Brown *et al.*, 2000). Bearing in mind the sustainability's input / output rule (Goodland and Pimentel, 2000) it is possible to establish health and sustainability criteria at a landscape scale. A sustainable landscape, or one being in good health, would be that in which the arrangement of the mosaic's elements and the interchange thereof would guarantee that the input and output rules be abided by.

The concepts of integrity, health and ecological sustainability make it possible to give formal expression to the desirable characteristics of the ecosystems in such a way that the conservation objectives be clear and convincing to society. The natural ecosystems' goods and services are related to the preservation of ecological integrity. Allegedly, the more integrous an ecosystem is, the more guaranteed the goods and services provided by it would be. The concept of ecological integrity is being gradually incorporated into technical and political documents on the environment (Council of Europe, 1996; Stanners and Bourdeau, 1995).

Both in an eco - regional context and in that of the landscape, the ideas of health and sustainability must be based on the complementalness of functions among the different types of ecosystems with the different degrees of human intervention they are made up of. The set of protected areas must be organised in the manner of a network or a system, so that it can make a contribution towards the ecological health of the territory as a whole. In this mosaic we will differentiate between the functions of the strictly protected natural areas (whose purpose would be that of guaranteeing the greatest possible ecological integrity), and the functions of other areas devoted to activities related to agriculture, forestry and cattle raising (where the objective can be keeping the ecosystem healthy by meeting certain conditions of sustainability), and certain intensive agricultural uses, as well as urban and mining - related ones, etc, which shall not be capable by themselves of meeting the demands posed by sustainability, and which only in the context of landscapes able to take such stress would be viable or admissible. The final purpose is that of guaranteeing the operation of basic ecological processes in the territory as a whole (Noss, 2000).

The aim of a nature conservation network is that of making a contribution to this general purpose of the territory.

2.3. Contributions made by landscape ecology to the design of networks

Any modern approach to the conservation of nature or biodiversity must analyse the role to be played by each element of the landscape, by taking into consideration its contribution to the health of the ecosystems. The aim of conservation is not limited to unspoiled areas; it is also necessary to assess the role played by managed ecosystems with regard to agriculture, cattle raising and forestry, and even, more modest though it may be, the role played by metropolitan environments. The way in which these activities are distributed and combined within the territory is relevant to the dispersal of species, to the regulation of flows and to the wide range of ecosystem functions.

Landscape ecology can be deemed to be the study of interactions between landscape patterns and ecological processes; specifically, the study of the influence of the said patterns on the flows of water, energy, nutrients and the biota (Turner, 1989). Two are the essential contributions made by this science to

deal with the management of ecosystems on a territorial scale. Firstly, it establishes relations between the structure of the landscape and relevant ecological processes with a view to creating environmental goods and services. Secondly, it provides a hierarchical framework to interpret the structure, function, change and stability by taking into consideration the scale of the analysis and by establishing relations among different scales. The landscape is a mosaic made up of patches which are different from one another in their environmental conditions and in the species they contain. It is also a mosaic showing the diversity and intensity of uses of the territory by society. The patches regulated by human activities are characterised by the greater amount of artificial energy invested and by the rejuvenation and simplification of the ecosystems supported by them. Those patches having natural covers and lacking disturbances will have, environmental conditions being equal, a greater complexity and diversity.

Within a territory, natural ecosystems of a high ecological productivity and large biomass, such as forests; the high productivity and low biomass ecosystems, such as many wetlands subjected to a regime of frequent disturbances; and the scarcely productive ecosystems such as, for instance, the deserts, are arranged in such a way that they create contiguous patches. All of them can be home to key species, rare species, relict species or endemic species which require a demanding conservation effort. Another wide range of semi - natural ecosystems have an intermediate - intensity management with a limited investment of artificial energy. These systems are combining the presence of exploited species with that of other species adapted to the ecosystems influenced by man, and with some others which make the most of the plots of land having natural cover and remaining within the agricultural matrix.

The landscape turns out to be this more or less heterogeneous mosaic which combines ecosystems with a different degree of integrity, which cover different areas in a manner that changes as time goes by. The biodiversity of the territory and the conservation of ecological processes is not only the result of the area covered by each type of ecosystem, but also of the way they are spatially combined, of their degree of fragmentation and isolation. Ecological characteristics of the landscape such as connectivity, heterogeneity or fragmentation, are determining factors of the biological wealth and of the operation of the ecosystems.

In the same way as the wealth of species is important for the operation of an ecosystem, the diversity of ecosystems in a landscape can be crucial for the

regional operation. Under certain circumstances, the patterns of size, shape and imbrication of the ecosystems in a landscape have a profound effect upon its operation.

The patterns of landscape organisation and heterogeneity have important implications for the usefulness of protected areas for the preservation of species in the face of climatic change. The planning and management of these areas do require, therefore, to know which are the factors which control the biophysical processes being responsible for the integrity of the ecosystems, so that their long - term survival be guaranteed, as well as their capability to endure disturbances. Putting into effect this type of criteria enables us to detect systems which are vital to global operation, but which are outside usual assessment methods.

2.4. From natural protected areas to systems

It is always a big mistake to confuse the end with the means. Natural protected areas could well have been, at the beginning of their history, an end by themselves. Nowadays they are preferably conceived as an instrument intended for reaching ends beyond their geographical boundaries. Protected areas are a useful and efficacious instrument of territorial management, spread all over the world as tools and means of intervention well characterised and tested. A natural protected area is deemed to have reached the active management level if it has, at least, a management or handling plan, a budget and personnel qualified to carry out actions (EUROPARC - España, 2002). The management plan must include specific operational objectives, with clearly defined activities and expected results and with a set of instruments to verify and assess the process. The management materialises in the territory, thus constituting an illustrative example for the surrounding environment. This is the reason why natural protected areas are a good starting point to take care of the goods and services that natural and semi - natural ecosystems provide us with.

The selection criteria to be applied to the territory suitable for the establishment of natural protected areas, must be the contribution to the keeping of processes supporting environmental goods and services, in addition to the preservation of unique places and representative enclaves. By way of example, in order to guarantee the presence of the key elements of the water flow in the landscape it is necessary to preserve the forest cover at the head of the basin, the natural and permeable state of the refill and discharge areas, and the continuity

and lack of contamination in the surface streams. The keeping of the valley / mountain complementariness, essential for many animal species in Mediterranean environments, entails the continued existence of protected areas in both sectors and their natural connection. The regulatory capability of nutrient flows depends on the location of highest - production ecosystems in key places, preventing the release of nutrients into sensitive environments (free waters, aquifers, etcetera). Generally speaking, a larger and more persistent biomass is an indication of the integrity of the ecosystem.

As we have seen, the interest in the definition of natural area networks was born, on the one hand, as a response to the deficiencies of the conservation principle based on isolated areas or individual species, and, on the other hand to try and find a coordination in the management of the different areas. The criterion adhered to for the establishment of these networks has usually been that of the representativeness of the different types of ecosystems, environments, habitats or species. As it was pointed out by González Bernáldez (1988), lack of knowledge of the majority of functional aspects, together with the urgency of adopting protective measures, has led to the fact that the most frequent policy of area designation be that based on this criterion of representativeness.

The different models of networks of natural protected areas in existence pay preferential attention to different criteria when it comes to their being established. We can highlight the following approaches:

- *Catalogues or inventories of natural areas.* It represents one step further as against the simple consideration of isolated areas. In general, the representativeness criterion has been used. The array of areas incorporated into the network does provide a degree of representativeness of ecosystems, habitats, species, endemic or threatened species, etcetera. Each new area increases the network's representativeness by a certain percentage when it has new ecosystems, habitats and species incorporated into it.
- *Administrative or institutional coordination networks.* These are not networks in any spatial sense (the existence of functional connections being unnecessary), but administrative coordination systems concerning the objectives, the selection criteria or the management models.
- *Ecological networks.* The main criterion for the establishment of these networks is the guarantee of connectivity. The whole array of protected natural areas becomes integrated into the network by means of territorial elements which facilitate the continuity of ecological processes (specially,

the linkage of populations). The model includes corridors and buffer zones which constitute facilities to guarantee this flow of organisms.

- *Systems*. The systems are characterised by guaranteeing ecological integrity. The territory is analysed as a whole, not only bearing in mind the representativeness and connectivity criteria, but also those of complementariness, internal coherence and external coherence. In a system approach, both the protected territory and other territorial elements are taken into consideration; specially, semi - natural ecosystems, which can play an important role as interconnection and buffering zones. This approach has not been developed in practice as yet.

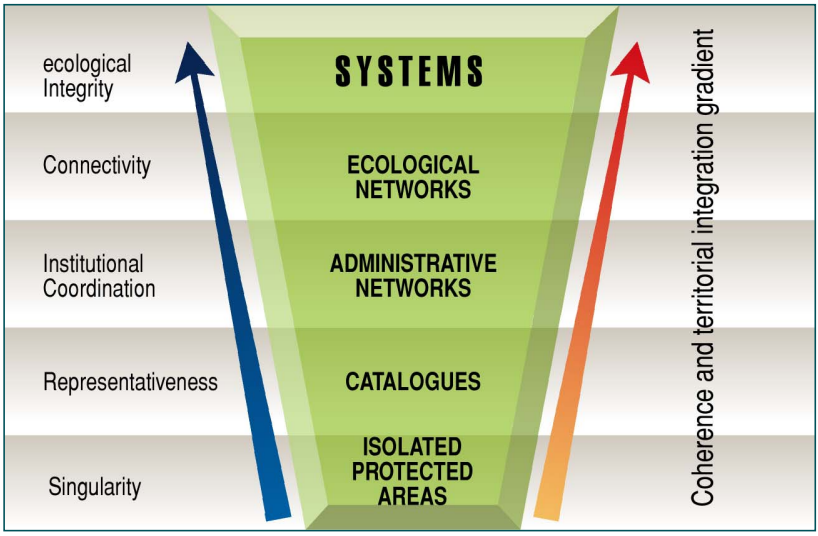

Figure 2.1. Conservation strategies: towards the establishment of natural area systems. To the left are the criteria carrying the most weight in each phase. To the singularity criterion, the prevailing one in the first stages of the design of isolated protected areas, the representativeness and institutional coordination criteria are being added in the stages of area catalogues and networks mainly administrative in character. The connectivity criterion comes on top of the previous ones in the ecological - network design strategy. The integrity criterion does define the system - devising strategy.

A conservation network must consist of patches being home to entire ecosystems (primary ecosystems, high - maturity and diversity ecosystems, secondary though they may be); the said patches must be accompanied by a series of physical or functional continuity playing a relevant role since they are home to natural and semi - natural ecosystems. They are usually known as transition or buffer zones even though its role of preference is not always this one. These zones usually reach high biodiversity levels due to their landscape heterogeneousness. They are frequently managed as systems of extensive

agriculture, forestry and grazing. When the natural conditions of the territory are altered due to urbanization or to intensive agriculture, it makes sense to guarantee the connection between urban centres by means of the creation or the keeping of ecological corridors.

The ways to act in order to maintain the connectivity of natural ecosystems will depend on the nature of the landscape's matrix where action is intended to be taken. Hobbs and Wilson (1998) distinguish four types of matrix ranging from the completely natural one to an artificial matrix. On top of this simple diagram an ecosystem transformation gradient could be placed, from those having a higher degree of integrity (pasture lands) up to and including the highly transformed ones (intensive agriculture).

By way of summary, if we conceive landscape as a mosaic made up of patches having different degrees of ecological maturity and being different from each other due to their environmental qualities and to the organisms which they contain, the conservation network or system would be the pattern of the natural /semi - natural /intensive /artificial mosaic making the best contribution to maintaining ecological integrity. Then, we would have to think less of a network being formed as a net consisting of knots and connections and more of a hierarchy of processes within the territory, for each one of them occurs in a certain spatial extension.

The key consists in identifying the manageable processes in the time - space scale of the protected natural areas leaving other levels of regulation in the hands of other spheres of government. For instance, the management of hydrological processes at the basin level does encompass the management of resources related to the whole variety of ground uses and economic activities in the basin. The management of such resources should be consistent with that of the protected areas situated in the said basin. Obviously, a network of protected areas can hardly contribute to the integrity of the hydrological cycle unless their actions are backed by other in different administrative areas.

2.5. Coming challenges to be met to improve protected natural areas

Protected areas envisaged as conservation islands have proven the inefficaciousness of setting up measures which do not take into account the

processes taking place outside their boundaries. The contribution made by protected areas to the conservation of the territory as a whole requires paying attention to their role with regard to the ecological health and to the keeping of a certain integrity within the territorial sphere. This strategy does entail a greater integration of conservation policies into the territorial planning by means of the development of coherent spatial structures, not to mention a high degree of cooperation and coordination among official bodies.

The process of moving into the planning of the whole array of natural protected areas in a wider territorial framework is still at an early stage in Spain. The coordination with other instruments of territorial planning remains the big challenge that must be faced in the coming years, as identified in the *Action plan for Spain's protected natural areas*. In the preparation of the said Plan, the following recommendations have been identified in relation to the planning of the systems of protected areas (EUROPARC-España, 2002):

- To develop a system in each self - governing region and with the appropriate territorial coordination among official bodies. This system must integrate such elements as are capable of guaranteeing the operation of the territory: protected areas, buffer zones and biological connections.
- To use a planning system in cascade with a view to optimising the use of human and material resources, and as a mechanism to guarantee greater coherence.
- To develop methodologies intended for the establishment of the criteria for the selection and the specifying of system areas.
- To develop the system planning document, its relation to the territorial planning and the definition of its contents.
- To integrate the planning of the system into the sectorial policies through the strategic environmental assessment of plans and programmes.
- To establish coordination mechanisms with bodies, agents and those territorial and sectorial planning instruments having a close relation to the protected areas.

The definition of a nature conservation strategy encompassing all these aspects should include scientific knowledge as well as the experience already gained in other countries. For the undertaken strategy to be realist and capable of being implemented, it will be, besides, indispensable to identify the administrative and legal instruments that can guarantee the necessary coordination.