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Biodiversity Vision

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LA CONSERVAZIONE ECOREGIONALE E LA BIODIVERSITY VISION DELLE ALPI

Ecoregional Conservation and Biodiversity Vision for the Alps

La Conservazione Ecoregionale e la Biodiversity Vision delle Alpi

Contributi al Piano Nazionale per la Biodiversità

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COUNTDOWN 2010 SAVE BIODIVERSITY · IUCN The World Conservation Union · UNEP

Con il patrocinio di: Rappresentanza in Italia della Commissione Europea, Conferenza delle Regioni e delle Province Autonome, IUCN Comitato Italiano, Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Ministero delle Politiche Agricole Alimentari e Forestali, Presidenza del Consiglio dei Ministri, Programma Ambiente Nazioni Unite/Piano d'Azione Mediterraneo

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1. Conservazione ecoregionale > Introduzione

Nel 1999, il WWF ha dato inizio ad un programma per arrestare la perdita di biodiversità nel mondo. Più di 200 aree del globo sono state riconosciute come particolarmente importanti per la conservazione della biodiversità.
Le Alpi sono una di queste ecoregioni e costituiscono la più vasta ed alta catena montuosa dell'Europa occidentale e possono venir considerate, nel loro insieme, un'unità biogeografica.
È però solamente negli ultimi anni che le autorità politiche hanno cominciato a riconoscere le Alpi nel loro insieme e sono quindi state in grado di proporre una politica pan-alpina.
Nel 1991, gli otto paesi alpini (Francia, Monaco, Italia, Svizzera, Liechtenstein, Germania, Austria e Slovenia) e l'Unione Europea hanno firmato la “Convenzione delle Alpi”, un accordo per lo sviluppo sostenibile di questa regione transfrontaliera.
Nella Convenzione, i firmatari si impegnano ad una collaborazione internazionale per conservare il patrimonio naturale di queste montagne. La Convenzione sulla Biodiversità delle Nazioni Unite, che nel frattempo è stata ratificata da tutti i paesi alpini, persegue lo stesso scopo.
Con l'approccio ecoregionale, il WWF dimostra che l'obiettivo di questi trattati internazionali può essere raggiunto. Per conservare la biodiversità nelle Alpi, abbiamo bisogno di azioni concrete, sia a livello pan-alpino sia nelle aree dell'ecoregione stessa aventi caratteristiche ecologiche prioritarie. Negli ultimi anni, insieme ai partner pan-alpini: ALPARC (Rete delle Aree Protette Alpine), CIPRA (Commissione Internazionale per la Protezione delle Alpi) e ISCAR (Comitato Scientifico Internazionale per la Ricerca Alpina), il WWF ha posto le fondamenta necessarie per la prosecuzione comune dei lavori. Oggi sappiamo quali aree della regione alpina meritano particolare attenzione per la loro ricca biodiversità.
Ma la conoscenza di per sé non basta. Sono necessarie misure e azioni concrete per bloccare la perdita quotidiana di biodiversità e conservare sul lungo periodo le risorse naturali. Il WWF ha quindi sviluppato un Piano d'Azione Ecoregionale (dettagli nel capitolo 7) e contribuirà concretamente alla sua attuazione.
La protezione della biodiversità non può essere raggiunta da una sola ONG. Per questo motivo, il Piano d'Azione elaborato è in primo luogo un invito a chiunque abiti, lavori o visiti le Alpi ad affrontare questa sfida insieme. Il patrimonio naturale unico delle Alpi e i suoi magnifici paesaggi meritano di essere protetti!

Introduction

In 1999, WWF initiated a programme to halt the loss of biodiversity worldwide. Over 200 areas of the globe were recognized as being especially significant for maintaining biodiversity.
The Alps are one of these ecoregions. The Alps are the largest and highest mountain system in Western Europe and can be considered a bio-geographical unit. But it is only in the last few years that political authorities have begun to recognize the Alps as a coherent structure and were thus able to carry out a pan-Alpine policy.
In 1991, the eight Alpine countries (France, Monaco, Italy, Liechtenstein, Switzerland, Germany, Austria, Slovenia) and the European Union signed the “Alpine Convention”, an agreement for the conservation and sustainable development of the Alps.
In the Alpine Convention, the contracting parties commit to cross-border cooperation aimed at preserving the rich natural heritage of the Alps.
The UN Convention on Biological Diversity, which all Alpine Countries have ratified, pursues the same goal.
With its ecoregional approach, WWF shows that the goal of these international agreements can be reached.
To preserve the biological diversity of the Alpine region, we need concrete actions, both at a pan-Alpine level and in those areas within the ecoregion that have a high conservation priority.
Over the last few years, together with the pan-Alpine networks of scientific research (ISCAR), protected areas (ALPARC) and NGOs (CIPRA), WWF has laid down the necessary foundations for this work to progress. Today, we know which areas in the Alpine Region deserve special attention with regard to their biodiversity.
But knowledge alone is not enough. We need concrete measures and action to halt the daily loss of biodiversity and to preserve the natural resources in the long term. WWF has therefore developed an Ecoregional Action Plan and will contribute to its implementation.
The goal of preserving biodiversity cannot be reached by any single NGO. This Action Plan (presented in chapter 7) is therefore primarily an invitation to everyone, whether living and working in the Alps, using Alpine resources or coming here as a visitor. Let us address this challenge together! The unique natural richness of the Alps and their beautiful landscape encourage us to do so.

The Global 200

The Global 200

In order to conserve biodiversity, a comprehensive strategy is necessary, taking various scales of intervention into account.

In the 1990s WWF and The Nature Conservancy undertook a comprehensive analysis of the biodiversity of the planet. As part of this exercise WWF identified 867 terrestrial ecoregions within fourteen biomes and eight biogeographic realms. Several large conservation organizations have defined an ecoregion as an effective unit for biodiversity conservation. An ecoregion is a relatively large unit of land or water that contains a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions (Dinerstein et al. 2000). A terrestrial ecoregion is characterized by a dominant vegetation type, which is widely distributed in the region – although not universally present – and gives a unifying character to it. Because the dominant plant species provide most of the physical structure of terrestrial ecosystems, communities of animals also tend to have a unity or characteristic expression throughout the region (Dinerstein et al. 2000).

The 867 ecoregions were then prioritized and 238 of them were selected as most important at global level. They represent the best examples of each major habitat type found on Earth and are under some degree of threat (endangered, vulnerable, etc.). Together the 238 priority ecoregions represent the *Global 200* (Fig. 1a): they include about 90% of the biodiversity of the planet. If we succeed in conserving these 238 ecoregions, we will have conserved the largest part of biodiversity, representing all major habitat types.

In Europe, the list of priority ecoregions is also accepted/shared by the European Environmental Agency (Fig. 1b).

Ecoregions are most suitable units for conservation planning because their scale is such that they:

– include the main driving ecological and evolutionary processes that create and maintain biodiversity;
– ensure the maintenance of vital populations of the species that need the largest spatial areas, an element of biodiversity that cannot be accommodated at the site scale;
– encompass a set of biogeographically-related and distinct communities for representation analyses;
– host a wide spectrum of socio-economic factors that together influence the status of biodiversity; and
– enable us to determine – within each ecoregion - the best places on which to focus conservation efforts, and to better understand the role that specific projects can and should play in the conservation of biodiversity over the long term (conservation priorities).

"Act locally, think globally" is a useful motto because, although we invariably have to act locally, without thinking more broadly at global or regional scale, we lack a context (biological, social and economic) for specific local actions that will produce long-term conservation benefits (Dinerstein et al. 2000).

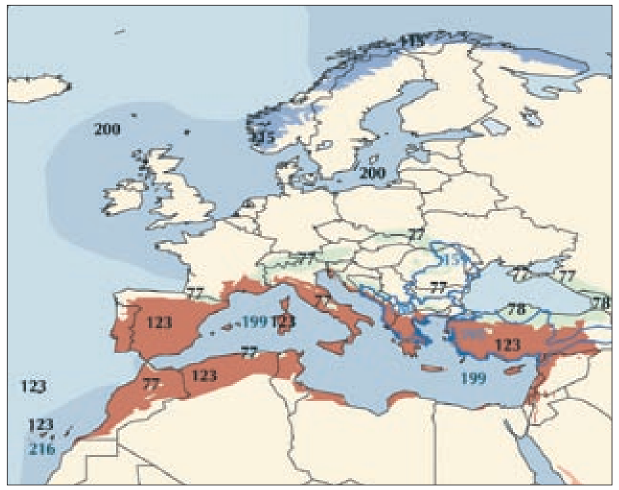


Fig. 1b. Priority ecoregions in Eurasia. Ecoregion no. 77 corresponds to European-Mediterranean montane mixed forests and includes the Alps, the Carpathians, the Dinaric Arc, the Pyrenees and other regions with the same major vegetation type. Ecoregion no. 78 is Caucasus-Anatolian-Hyrcanian Temperate Forests. Ecoregion no. 115 is Fenno-Scandia Alpine Tundra and Taiga. Ecoregion no. 123 is Mediterranean Forests, Woodlands and Scrub. Ecoregion no. 159 is Danube River Delta. Ecoregion no. 180 is Balkan Rivers and Streams. Ecoregion no. 195 is Anatolian Freshwater. Ecoregion no. 199 is Mediterranean Sea. Ecoregion no. 200 is Northeast Atlantic Shelf Marine.

Fig. 1a. Global 200 project, map showing the ecoregion chosen by WWF International

Ecoregion conservation

Ecoregion conservation is an approach developed by WWF, TNC and CI to work in ecoregions. It can be thought of as an advanced ecosystem approach. It consists of 4 main steps.

1) The reconnaissance phase: to clarify the context and assess the feasibility and the appropriateness of launching an ecoregion initiative (this is where initiatives already in place are reviewed). If at the end of this phase the conclusion is that an ecoregion initiative is not appropriate, the process will stop here. If, on the contrary, the conclusion is that an ecoregion initiative is warranted, the process will proceed with the next three steps;
2) the biodiversity vision: to develop a desired scenario for biodiversity at least 50 years into the future, which will guide the strategies and the actions for the conservation of biodiversity in the ecoregion. The biodiversity vision includes the identification of the priority areas important for the biodiversity of the ecoregion as well as the corridors among them and from the ecoregion to adjacent regions (connection areas or macro-corridors). The vision is the very innovative element of ecoregion conservation compared with the ecosystem approach;
3) the ecoregion conservation plan: to identify and design the actions and the programmes needed to conserve the biodiversity of the ecoregion in the face of the trends, the threats and the needs of the human population. This plan addresses both the ecoregional themes (issues valid at ecoregional scale) and the needs of the priority areas and the macro-corridors. Such plan needs to be reviewed periodically against changed conditions and priorities, or based on the results of monitoring and evaluation;
4) the implementation of the conservation plan: to put into effect the actions and the programmes identified in the ecoregion conservation plan. This phase will take as long as needed, up to several decades. The implementation programme also needs to be reviewed on the basis of the results of monitoring and evaluation. Several organizations can take responsibility for different components of the conservation plan.

It is important to note that concrete, on-the-ground activities can be implemented during this process, even before the biodiversity vision and the ecoregion conservation plan are developed. These activities should be in response to urgent needs, immediate threats or existing important opportunities. They are therefore not permanent: they end when the reason for their existence expires; they are launched or modified when the situation changes or new information becomes available.

Two of the most important components of ecoregion conservation are monitoring and evaluation: the effectiveness of the actions implemented should be kept under check and the plans modified according to the results of the evaluation. Ecoregion conservation is thus based on adaptive management.

Other crucial components are partnerships and collaboration with other parties. Throughout the four phases of the process it is important to work together with others: if there is an animator, this animator has to extensively involve others in all steps. Which partnerships to form or which interested parties to involve depends on the individual phase of the process and on the local situation. Without the participation of these parties, ecoregion conservation does not have ground to exist.

Biodiversity components according to ecoregion conservation

For a biodiversity conservation strategy to be effective it should address the fundamental goals of biodiversity conservation (modified from Noss 1992):

Goal 1: Representation of all distinct natural communities within conservation landscapes and protected areas networks;

Goal 2: Maintenance/restoration of viable populations[1] of all native species within their natural communities;

Goal 3: Maintenance/restoration of ecological and evolutionary processes that create and sustain biodiversity;

Goal 4: Conservation of blocks of natural habitat large enough to be resilient to large-scale stochastic and deterministic disturbances and long-term changes.

Goal 1 to 4 are also considered the “pillars” – or “components” – of biodiversity conservation. The biodiversity vision of the Alps was developed keeping in mind these components.

WWF and other international conservation NGOs developed a methodology to meet these goals for biodiversity conservation within ecoregions.
The methodology is called *ecoregion conservation* and it draws on the existing knowledge of biodiversity in the ecoregion and on the involvement of the conservation community within the region. Although it is rapidly evolving from its original template, the main traits of the methodology have remained the same and the procedure applied for the Alps is similar.

[1] “Viable” means the species population is large enough to have a high probability of surviving within the next 100-200 years.

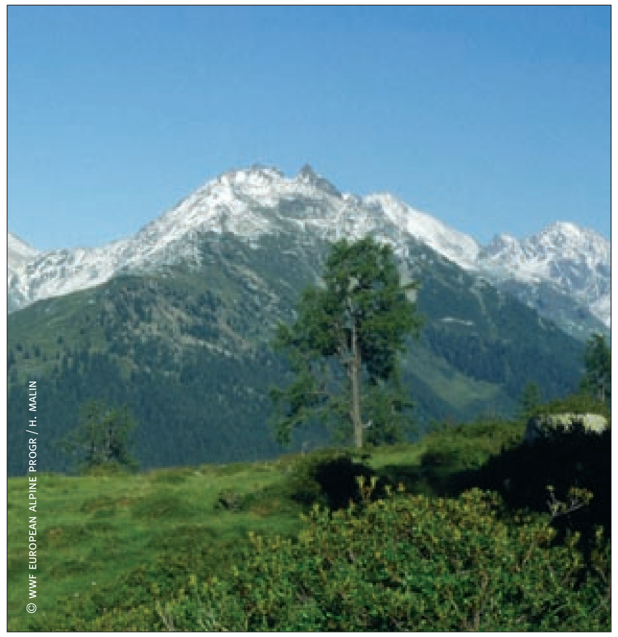
2. Description of the Alps Ecoregion

2. Descrizione dell’Ecoregione Alpi

Le Alpi costituiscono una delle più grandi ed alte catene montuose del mondo e formano un arco della lunghezza di 1.200 km che si estende da Nizza a Vienna su una superficie di circa 191.000 km^2 (i limiti dell’ecoregione alpina sono stati individuati in corrispondenza della Convenzione delle Alpi). Attraversano otto paesi differenti: Francia, Monaco, Italia, Svizzera, Liechtenstein, Germania, Austria e Slovenia.
Sono allo stesso tempo tra gli ecosistemi più intensamente sfruttati al mondo e una delle aree più ricche di biodiversità in Europa. In questo capitolo ci concentreremo sulle caratteristiche del paesaggio, della geomorfologia, del clima, dell’altitudine, dei processi dinamici, dell’influenza umana, della flora e della fauna di questa catena montuosa. La ricchezza della biodiversità va ricercata nel gran numero di habitat differenti, principalmente dovuti alle grosse differenze di altitudine, ma anche alla differenza della composizione del suolo (calcareo o siliceo) e agli eventi storici, quali le glaciazioni del Pleistocene e la presenza umana in queste aree già sin dal Neolitico.
Bisogna inoltre notare che i limiti definiti per l’ecoregione alpina sono stati stabiliti dalla Convenzione delle Alpi, per motivi pratici e politici.

Description of the ecoregion

The Alps are one of the largest and highest mountain ranges in the world, forming an arc of 1.200 km in length from Nice to Vienna and covering about 191.000 km^2 (the Alpine Ecoregion was delineated according to the application area of the Alpine Convention).
This territory is shared by eight different countries: France, Monaco, Italy, Switzerland, Liechtenstein, Germany, Austria and Slovenia. One of the most intensively exploited mountain ecosystems in the world, the Alps also represent one of the richest biodiversity hot spots in Europe.



Landscape

The high level of biodiversity is mostly due to the small-scale horizontal and vertical structure of the Alps. The marked differences in altitude, geology and climate result in a multitude of different habitats. However the ecological patterns are not only determined by these abiotic environmental factors. They also reflect historical events such as the Pleistocene glaciations and human presence dating back to Neolithic times.

Geomorphology

The mountainous terrain is highly fragmented and topographically varied, leading to great habitat diversity. The Alps are one of the youngest mountain systems in the world; they have developed from the Tertiary period to the present through collision, upheaval and erosion. Deep valleys were carved by rivers while sediments deposited in the lowlands, forming today an envelope of young sedimentary rocks. The step-like morphology was shaped by the Pleistocene glaciation periods, when most parts of the Alps were covered by an enormous ice cap. Only in the south, the southwest and the east large areas were free from continuous ice-cover. Valley glaciers shaped the contours of the slopes and left massive moraine deposits in the valley floors. The geologic substrata are very varied and form a mosaic pattern in some places. The bedrocks can be divided into two major types: calcareous and siliceous. As a general rule, the enveloping outer chains are built of calcareous while the inner ranges are made of siliceous materials. The composition of the bedrock significantly influences soil formation and ultimately the plant cover. As some plants prefer calcium-rich soils, while others grow better in soils poor in calcium, pronounced differences occur between the vegetation inhabiting the various substrata, even when climatic conditions are almost identical. Alpine soils are in very different stages of development depending on the altitude, slope, exposure and age of the deposits.

Climate

The Alps are an interzonal mountain system situated between the temperate life zone of central Europe with deciduous (broad-leafed) forests and the Mediterranean life zone with evergreen forests. With the exception of the southwestern most Alps and some sheltered spots along the southern fringe, most of the area is influenced by a cold temperate climate, characterized by precipitation during the warm periods and winters cold enough to induce vegetation dormancy. The climate varies remarkably from the outer regions to the valleys of the interior and from east to west. Inner valleys can be very dry; the northern and southern slopes, however, receive a relatively large amount of rain in summer and snow in winter.

Altitude

Annual air temperature mean values decrease by 0,55°C with every 100 m of increasing altitude. On the other hand, solar radiation is significantly stronger at high altitudes. Therefore soil and vegetation receive more heat, even though air temperature is considerably lower. Sharp thermal contrasts and major temperature fluctuations make strong demands on plants, their water budget being particularly affected. Moreover, winds are particularly strong at high altitudes, thus increasing evaporation in plants. Strong nocturnal heat emission in the mountains exposes plants to frost danger throughout the year. The duration of snow cover also increases with altitude. Flowering plants can only grow in places that are snow-free at least for a brief period. Due to these striking changes in climate with increasing altitude, the vegetation of the Alps is divided into more or less sharply defined altitudinal belts. Summergreen broad-leafed trees characterize the low hilly belt. The montane belt is mostly made of mixed stands of coniferous trees. The forest line, i.e. the superior limit of closed-canopy forests, defines its uppermost boundary. Above this line lies the subalpine belt, the transition between the montane and the alpine belt. It is characterized by open forest stands and krummholz (trees whose growth is stunted by the harsh climate). The alpine belt starts above the tree line and consists of dwarf scrub and grassland. Its uppermost boundary is defined by the limit of the closed grass-cover. The belt under the snow reaches up to the climatic snow line. It consists mainly of isolated patches of grass and cushion plants. In the topmost snow belt, flowering plants occur only on local warm rock niches. The level of each altitudinal belt is higher in the central Alps than in the outer ranges. In the daytime in summer large massifs warm up more than isolated mountain groups. Plants living in the central Alps must therefore endure starker temperature contrasts than species inhabiting the outer Alpine ranges. On the other hand, vegetation can reach higher altitudes because diurnal temperatures rise higher. Right up to the present day, human activities have dictated the altitude of the tree line. The Alps were probably one of the first ecosystems where important areas were cleared to allow grazing during the Neolithic Age. Alpine meadows were extended downwards and the timberline was often lowered by a few hundred meters to obtain more land for pastures. Hereafter is a map showing the elevation differences in the Alps (Fig. 2).

Dynamic processes

Avalanches, rock falls, foehn-storms and periodic flooding by mountain stream are distinctive for this ecoregion. These natural processes are important because they incessantly create new habitats for plants and animals therefore representing a driving force for biodiversity. For example, plant diversity in avalanche tracks is significantly higher than in the surrounding forests. Avalanches break or uproot dominating trees and small plants profit from the increased light. Water and soil nutrients are also more abundant and many different environmental conditions are created by the varying dynamics of snow movement in the tracks. The more frequent the avalanches, the higher the plant diversity gets.

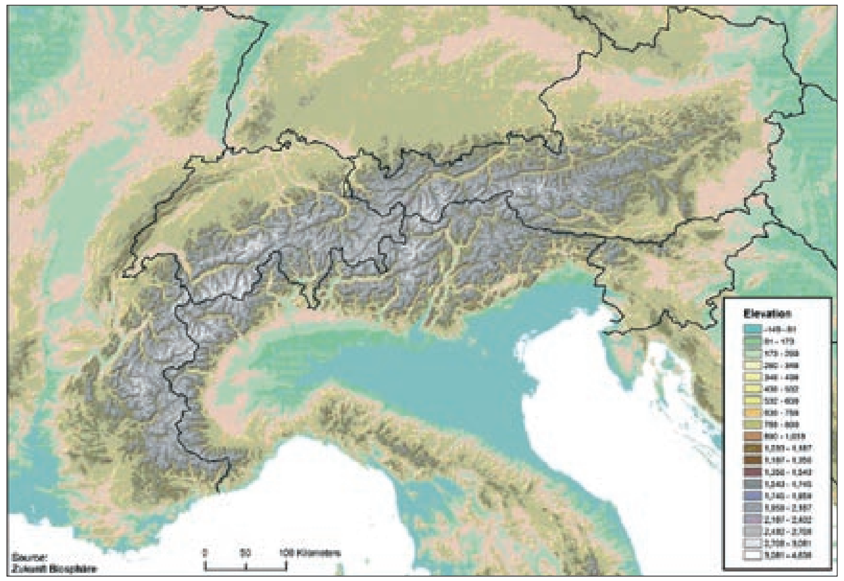


Fig 2. Map showing differences in elevation in the Alps

Human influence

Mankind has influenced the high-mountain ecosystems of the Alps since Neolithic times. Longstanding farming and livestock grazing activities in many parts of the Alps have resulted in a characteristic cultural landscape, which also plays an important role in maintaining biodiversity.

About a quarter of the plant community diversity is man-made or depends on particular forms of agriculture. This is especially true for the many types of mountain meadows. With up to 80 plant species on 80 m2, the extensive mown meadows between 1800m and 2200m belong to the most diverse plant communities in Europe. Despite the high level of human impact, the Alps are still home to wilderness areas, especially in the alpine belt. The Alps include some of the last remaining pristine areas in central Europe. A recent study on Alpine areas completely unaffected by human infrastructure found a total of 831 remote areas, of which 69 are larger than

100 km². Most of these remote areas are found in high, inaccessible mountain zones. Human impact decreases with altitude. Above the low montane belt, more than two thirds of the forests are only moderately altered, close to natural or natural; in the subalpine belt more than half of the forests are natural or close to a natural state. The degree of naturalness is highest in the central Alps. It is still fairly high in the northern and southern Alps but rather low in the forelands.

Flora

Due to the mentioned mosaic of different habitats caused by marked differences in altitude, micro-climate and soil, the Alps are one of the regions with the richest flora in Europe, second only to the Mediterranean region. The Alps host 4500 different vascular plant species. The flora diversity varies regionally: in the eastern Alps, there are 1.5 times more species on the southern than on the northern edge. In the western Alps this difference is even more noticeable. The irregular distribution of plant species richness is due to the climatic history, the intensity of the Pleistocene glaciations and the location of glacial refuges.

As mentioned before, the Alps are situated between different bio-geographic zones, which make for particularly diverse flora. On sheltered spots at the southern foot of the Alps, evergreen Mediterranean trees grow, while in the alpine and snow zones, arctic-alpine plants exist that are adapted to the extreme climatic conditions. During the Quaternary climatic fluctuations, plants migrated to the Alps. They were coming from mountainous areas in central Asia, southern Europe and Africa, as well as from the Arctic. During cold periods for example, the Arolla Pine (*Pinus cembra*) came from Siberia, the Edelweiss (*Leontopodium alpinum*) moved in from the Asian steppes while the Dwarf Birch (*Betula nana*) made the long trip from the Arctic. When the climate warmed up again, these plants did not disappear but simply retreated to the upper montane and alpine belts. Thanks to the dry climate, steppe plants also often inhabit lower altitude sites in the central Alps. During periods of strong glaciations, some plants survived in so-called refugia, i.e. sheltered spots in the Southern Alps. Through the topographic and climatic isolation of different mountain areas, new species emerged which are still endemic to the Alps. There are 417 endemic vascular plants in the Alps. Some of these are exceedingly rare, for example *Berardia subacaulis*, which can be found only in some areas of the French Alps. Endemic species are distributed very unevenly. Centers with a high proportion of endemics are located in the south-western and south-eastern Alps, due to the location of refugia during the glaciations. The number of endemic and rare plants increases with altitude. Many are restricted to subalpine and alpine altitudes where harsh conditions limit plant growth. Plants had to adapt to major fluctuations in temperature, to the danger of desiccation caused by wind and frost and to the lack of nutrients in the shallow soils. Most plants above the forest line are small and grow in flat cushions, rosettes or carpets to protect themselves from the wind and to resist the pressure of heavy snow layers (e.g. *Silene acaulis, Androsace Helvetica, Veronica bellidioides*). Many have large root structures and ample underground organs that function as water and nutrients storage systems and as anchorage in the soil. The Net-Leaved Willow (*Salix reticulata*), the smallest tree in the world, is barely 10 cm tall but has roots several meters long. Other plants protect themselves through dense hairiness, like the Edelweiss, or leathery leaves, like the Cow Berry (*Vaccinium vitis-idaea*). The following map is showing the different forest types found in the Alps (Fig. 3).

Fauna

The exact number of animal species in the Alps is unknown, though estimates place that number at about 30 000. In the western Alps only, more Carabidae (ground beetle) species have been counted than on the entire Scandinavian Peninsula and at least one third of them are endemic.

Approximately 200 different breeding bird species can be found in the Alps, and just as many are known to migrate trough, or spend the winter in the Alps.

There are 21 species of amphibians and 15 species of reptiles, including one endemic species, the large alpine salamander (*Salamandra lanzai*). Amphibians and reptiles are especially threatened, as many wetland habitats have been destroyed in the past century and roads have cut off migration routes.

About 80 mammalian species live in the Alps, most of them small ones like bats, shrews, mice and voles. None of them are strictly endemic. Some typically alpine animals like the marmot (*Marmota marmota*), the ibex (*Capra ibex*), the mountain hare (*Lepus timidus*) and the snow vole (*Microtus nivalis*) however, are genetically different from equivalent populations of other mountain systems in Europe or in the Arctic. Though all typical alpine mammals exist in the Alps, many of their populations have been reduced in size or have been disintegrated into small subpopulations.

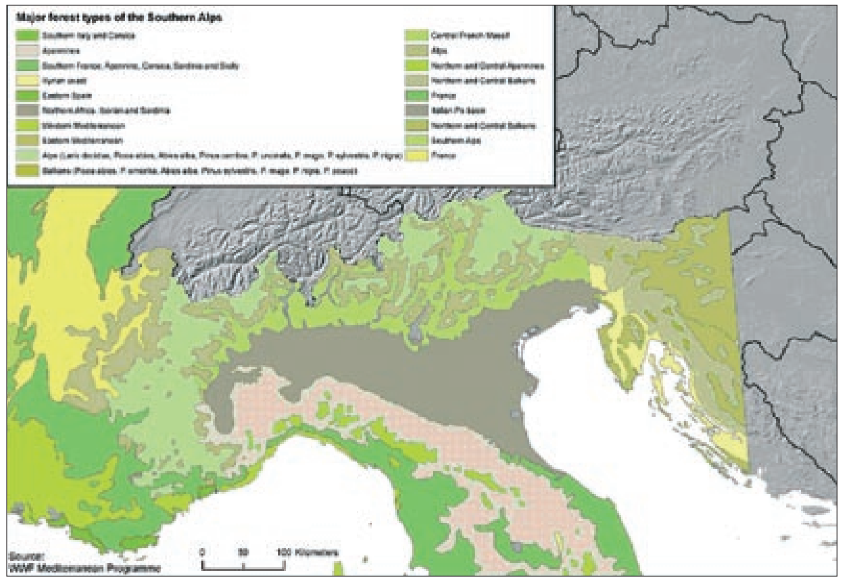


Fig 3. Map showing the forest types in the Alps

This is especially true for the large carnivores: the brown bear (*Ursus arctos*), the wolf (*Canis lupus*) and the lynx (*Lynx lynx*). All large herbivores, such as the red deer, the roe deer and the ibex, are nowadays widely distributed. The ibex was once on the brink of extinction but was reintroduced in the 19th century and the population is now considered secure. The otter, which is an indicator of good quality of river system habitats, is still present but has a very localized distribution. For example, it has completely disappeared from Switzerland.
With increasing altitude, living conditions are harsher and in the alpine belt a lot of species, especially birds and mammals, altogether disappear. The remaining species have shown different forms of adaptation to the difficult environmental conditions. The Alpine salamander (*Salamandra atra*), for example, does not lay eggs like most other reptiles but gives birth to fully developed young. Birds and mammals have thicker feathers or pelts and their feet or paws are perfectly adapted for treading on snowy surfaces. The mountain hare (*Lepus timidus*) and Ptarmigan (*Lagopus mutus*) change their brown coats to white in winter. Many animals hibernate during the coldest months of the year while others like the alpine chamois (*Rupicapra rupicapra*) and rock partridge (*Alectoris graeca*) migrate over more or less long distances or descend to lower altitudes. The ibex, instead, climbs to very steep slopes where the snow slides off and some food can still be found in winter. There are about 80 fish species living in alpine lakes and rivers. The type of fish living in larger rivers such as the Danube, Rhine, Rhone and Po, and their alpine tributaries, is very much determined by the fish fauna of their destination and are therefore very distinct in this regard. Many of the small lakes higher up in the Alps are originally almost devoid of fish or harbor only a few, specialized fish species. These two aspects - the convergence of fish fauna from distant sea regions up alpine rivers and a highly specialized fish fauna in small lakes and streams - make freshwater habitats in the Alps unique.

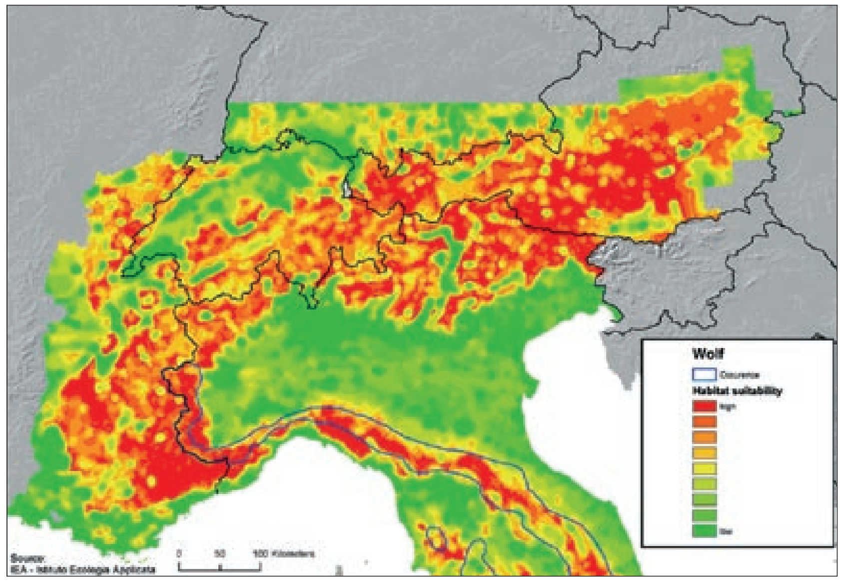


Fig. 4: Map showing potential suitable habitats for wolf in the Alps

The comeback of large carnivores and bearded vultures

During the 18th and 19th centuries, the human-caused decline of mountain forest areas, the ensuing disappearance of natural prey (large herbivores) for the lynx and the wolf and the strong increase of farming and livestock aggravated the conflicts between large carnivores and humans. Seen as dangerous competitors the lynx and the wolf were exterminated in the Alps. The brown bear was almost hunted to extinction. Today mountain forests have recovered. Large herbivores came back spontaneously or were re-introduced by man. In large areas, the natural habitats for large carnivores of the Alps are still intact.

As a result of the 1970s programmes for the re-introduction of the lynx, the species is once-again present in all Alpine countries. However, the populations are not yet secured. Wolves spread back into the Italian and French Alps from a surviving population in the Abruzzi region of Italy. Fig. 4 is showing potential suitable habitats for wolves in the Alps. Brown bears from the Balkans are returning to the Austrian Alps and are being re-introduced into the Italian Alps to back up a small autochthonous population. Seen as a success by conservationists, these comebacks are not without any problems. The Alps are densely populated, and wherever large carnivores get close to human settlements, harsh disputes ensue. In particular, livestock damage caused by wolves has recently sparked controversy. Still, the WWF is convinced that cohabitation between humans and large carnivores is possible. It can be achieved by the implementation of effective damage prevention measures and the conservation of sufficiently large natural habitats.
Bearded vultures became extinct in the northern Alps in 1885 and in the Southern Alps in 1913. There were several reasons for their demise. Food sources (wild ungulates such as deer but also domestic animals, particularly sheep) became scarce in the mountains. Bearded vultures were highly prized as trophies and the more rare they became the more sought after they were. Bearded vultures were also killed by sheep farmers who considered them a pest; they were accused of flying off with lambs picked from flocks.
The reintroduction of the bearded vulture (*Gypaetus barbatus*) into the Alps is a good example of how long conservation programmes can take before success is achieved. The re-introduction programme started in the 1970's but it wasn't until 1997 that the first chick was hatched in the wild. It will be many years yet before the population of Alpine bearded vultures is considered self-sustaining. Until 2004 129 bearded vultures have been released from zoological breeding programmes and 20 young birds were hatched in the wild.
The dominant vegetation type characterising the Alps ecoregion among the other Global 200 is the European-Mediterranean montane mixed forests. Other mountain regions in this part of the world share the same dominant vegetation type, for example the Carpathians, the Pyrenees and the Dynaric Alps. In the Global 200 classification they together constitute ecoregion no. 77. According to the analysis of the Global 200 campaign, the status of the Alps is considered "vulnerable/endangered". This threatened status makes it urgent to address conservation in the Alps at the ecoregion scale.

Boundaries of the Alps ecoregion

In the Global 200 classification, ecoregion boundaries are coarsely identified according to the distribution of the dominant vegetation type, with no detailed boundaries. In fact, one of the first recommended tasks for an ecoregional team is to identify more closely the boundaries of the ecoregion. For the Alps, early in the process it was decided that the ecoregion boundaries should reflect the area of application of the Alpine Convention.

The Alpine Convention

The Alpine Convention is the only existing policy tool covering the entire Alps, and solely the Alps. It was signed in 1991 by the eight Alpine countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia, Switzerland) and the European Union. It includes a framework convention and several thematic protocols. The Alpine Convention provides an official frame for ecoregional work and a good possibility for synergies on a political level. Adapting the biodiversity vision to the boundaries of the Alpine Convention would ensure a higher political acceptance for the results and an appropriate forum for their implementation.
In addition, under the auspices or the umbrella of the Alpine Convention, several studies have already been conducted and data collected for the entire Alps region.

3. The Biodiversity Vision

3. La Vision per la biodiversità

Le Alpi sono la catena montuosa più sfruttata del mondo. Rappresentano però anche il più vasto patrimonio di biodiversità in Europa, strettamente legato alla qualità della vita dei residenti e dei turisti che la visitano. Il WWF, in collaborazione con ALPARC (Rete delle Aree Protette Alpine), CIPRA (Commissione Internazionale per la Protezione delle Alpi) e ISCAR (Comitato Scientifico Internazionale per la Ricerca Alpina), ha proposto un progetto volto a identificare le aree alpine prioritarie per poi tutelarne la biodiversità. Tali aree sono state individuate nel corso di una ricerca biennale culminata nel 2002 in due workshop internazionali ai quali hanno partecipato scienziati, rappresentanti di organizzazioni non governative e istituzioni. Il primo workshop si è tenuto a maggio a Gap (Francia) e il secondo a settembre ad Alpbach (Austria). Questo capitolo illustra i risultati di questo complesso lavoro e si propone da un lato di favorire una migliore comprensione della biodiversità alpina, dall'altro di fornire una guida delle aree dove le nostre quattro organizzazioni ritengono prioritario intraprendere azioni di conservazione.
La nostra iniziativa per la biodiversità intende dare un importante contributo alla Convenzione delle Alpi, un accordo quadro stipulato dagli Stati del territorio alpino e dall'Unione Europea che impegna le parti ad attuare politiche di sviluppo sostenibile per questa regione montana transfrontaliera.
Questo trattato internazionale fa dell'area alpina un modello per altre regioni in Europa e nel resto del mondo. Il nostro primo grande risultato è stato la stesura della prima mappa delle aree alpine con i più elevati valori di biodiversità per piante, animali e habitat. La mappa indica dove iniziare ad agire, integrando la Convenzione delle Alpi e i suoi protocolli che definiscono in linea generale che cosa intraprendere e come. In tal modo gli aspetti concernenti la biodiversità potranno essere meglio integrati nella pianificazione e nelle decisioni a livello locale, regionale, nazionale e internazionale.
La Rete delle Aree Protette Alpine è un risultato importante della Convenzione e uno strumento essenziale per la conservazione della biodiversità. Tuttavia, anche se i responsabili delle aree protette sono oggi al lavoro per costruire una rete strutturata e solida che consenta lo scambio di informazioni ed esperienze, le diverse aree restano ancora isolate una dall'altra. Esse non sono connesse fra loro da corridoi ecologici e sono ancora troppo simili a isole, insufficienti a proteggere questo patrimonio naturale. Dobbiamo perciò dare maggior enfasi a pratiche di gestione efficaci e sostenibili attuabili anche al di fuori delle aree protette, soprattutto nelle regioni con elevati valori di biodiversità. Ed è in questo contesto che nasce anche la seconda parte del nostro progetto di una visione globale della biodiversità nelle Alpi con l'identificazione di aree di connessione tra le aree identificate e tra le Alpi stesse e le catene montuose europee adiacenti. Alcuni dei risultati preliminari sono già stati raggiunti con la consultazione di esperti e l'organizzazione di un workshop a Buchs (CH) nel settembre del 2005. Questa fase verrà però completata nell'ambito di un progetto più ampio d'identificazione di aree di connessione nelle Alpi.
La Convenzione delle Alpi, soprattutto con i protocolli "Protezione della Natura e Tutela del Paesaggio" e "Pianificazione Territoriale e Sviluppo Sostenibile", fornisce gli strumenti per raggiungere questi obiettivi nel medio termine.
WWF, ALPARC, CIPRA e ISCAR collaborano per contribuire alla tutela della biodiversità alpina. È fondamentale concentrare gli impegni di tutela innanzi tutto sulle aree con i più alti valori di biodiversità. Occorre garantire che gli aspetti legati alla biodiversità vengano presi in considerazione nelle fasi decisionali, che siano adottate misure adeguate ed efficienti per realizzare una rete ecologica protetta e che le zone limitrofe alle aree protette vengano gestite in modo sostenibile.
Le nostre quattro organizzazioni quindi incoraggeranno e attueranno progetti nelle aree ad alto valore di biodiversità, in collaborazione con le popolazioni locali, le autorità e i gruppi di interesse presenti sul territorio.
Desideriamo infine richiamare l'attenzione di tutti gli organismi dediti alla tutela della natura, affinché si uniscano a noi nell'impegno di proteggere quel patrimonio naturale universale che è la catena montuosa delle Alpi.

Introduction on the biodiversity vision

The Alps are the most intensively exploited mountains in the world. And yet they still represent Europe's largest pool of biodiversity, inextricably linked to the quality of life of its inhabitants and visitors, present and future.
WWF, in collaboration with ALPARC (Alpine Network of Protected Areas), CIPRA (International Commission for the Protection of the Alps), and ISCAR (International Scientific Committee on Research in the Alps) launched an initiative to determine the Alpine regions, which need to be given priority for conservation based on biodiversity values. These regions were identified in the course of a two-year process, culminating in two international workshops with scientists, representatives from NGOs, and institutions. The first workshop was held in May 2002 in Gap, France and the second in September 2002 in Alpbach, Austria. The results of this process contribute to a better understanding of biodiversity in the Alps and provide a guide to the areas in which priority conservation actions should be undertaken. The biodiversity initiative of our four organisations makes an important contribution to the Alpine Convention, a treaty among the Alpine states and the European Union which commits members to pursue a policy of sustainable development in this transnational mountain area. This international public law treaty makes the Alpine area a model for other regions in Europe and across the world. Our joint biodiversity initiative presents, for the first time, a map of regions in the Alps with high biodiversity value, integrating a diverse set of plants, animals, and habitats. It therefore shows where we have to act first, supplementing the Alpine Convention and its protocols which define which measures should be applied and how. In this way we can integrate biodiversity aspects more closely into planning decisions at local, regional, national, and international levels. The Alpine Network of Protected Areas is one significant outcome of the Alpine Convention. It is an important instrument for biodiversity conservation. However, while protected areas managers are now building a tight network allowing the exchange of information and experiences, the protected areas themselves are still isolated from each other. They are not adequately connected by ecological corridors, and as islands, are not sufficient to protect our natural heritage. Therefore, we need to emphasise effective and sustainable management practices outside protected areas, especially in the regions with high biodiversity values.
The Alpine Convention and especially its protocols "nature protection and landscape conservation" and "regional planning and sustainable development" provide tools for achieving this goal in the medium term.
Building networks WWF, ALPARC, CIPRA and ISCAR are working together to contribute to the preservation of biodiversity in the Alps. We believe that it is important to concentrate conservation efforts primarily on the identified regions with high biodiversity value. We want to ensure that biodiversity aspects are considered in planning decisions, that appropriate and efficient measures are taken to implement an ecological network of protected areas and that areas outside protected areas are managed in a sustainable way.
The four organisations will start to implement projects in cooperation with local people, relevant authorities, and interest groups within the high biodiversity value regions. We would like to call upon the conservation community to follow our example and join us in our effort to protect the natural heritage of the Alps.

The biodiversity vision

The biodiversity vision is the articulation of common goals among stakeholders. It is a strategic approach to move from global to local. Technically, the biodiversity vision is not a map, but a map helps to envision it. The biodiversity vision should include the identification (the map) of the priority conservation areas and the connection areas, a vision statement and a conservation plan. While the biodiversity vision is biologically based, actions are guided by the socio-economic reality.

Conservation priorities should be identified purely on their biological value; socio-economic considerations come in later and should be used to select the actions, understanding what has already been lost to human activities and using it as a bargain for all that remains. As a consequence, biodiversity experts should be involved in the identification of biological priorities, while socio-economic experts should be engaged in the development of strategies for their conservation.

Priority areas and connection areas are zones to focus on, and for the conservation and sustainable development of which to work for. For this reason, the map of priority areas and connection areas can also be called the biological priority map, or the map of conservation priorities.
The ecoregion conservation method to identify priority areas and connection areas is based on the knowledge already existing in and on the ecoregion. No new data collection is recommended to define the biodiversity vision, given that this step relies on a coarse (i.e., non detailed) scale (eventual new data collection is possible at a later stage, when priority areas and connection areas are identified and more analyses are needed at the landscape or site level).

History of the WWF European Alpine Programme

At the end of 1999 the 5 WWF organizations of the Alps (WWF Austria, France, Germany, Italy and Switzerland) decided to work together to assess the feasibility of launching an ecoregion conservation initiative for the Alps.

Several WWF projects had already been underway in the Alps, but these were mainly constrained within national boundaries and were rarely coordinated among the different countries. Other organizations or agencies had also attempted to address issues at the pan-Alpine scale (one was the Alpine Convention), but such initiatives were rare and far in between.

For the next year and a half the Alpine WWF organizations – with the contribution of independent experts – did a survey of what was underway in the Alps, by whom, with what results, and of the trends of biodiversity loss and socio-economic development. Such survey (called *Reconnaissance*) also included four rapid assessments: of biodiversity, of the socio-economic factors and decision-making levels, of the international policies with an impact on the biodiversity of the Alps, and of the interested parties in the region. The results of the survey were summarized in the Final Reconnaissance Report of June 2001, which was peer-reviewed by the directors of three key pan-Alpine organizations: the International Commission for the Protection of the Alps (CIPRA International), the Network of Alpine Protected Areas (ALPARC) and the International Scientific Committee for Alpine Research (ISCAR). These three organizations had been identified during the assessment of interested parties as the most knowledgeable, reputable and influential at Alpine scale.

The conclusion of the Reconnaissance Phase was that a pan-Alpine initiative of WWF according to the principles of ecoregion conservation would indeed be an added value to the status quo and would significantly contribute to the conservation of biodiversity in the Alps.

The next step was then the development of a biodiversity vision: the desired scenario for the biodiversity of the Alps 50 years down the road.

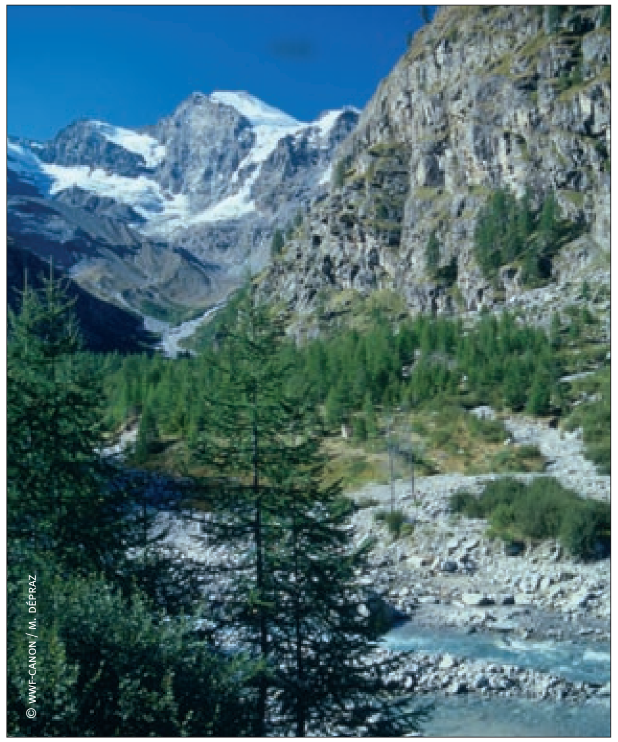
Methodology and results

The process started with the identification of partners. CIPRA International, ISCAR and ALPARC were identified as the best partners because of their pan-Alpine vision, knowledge of the Alps, experience, long history (CIPRA International was founded in 1952), link to the Alpine Convention and potential interest in the WWF proposal of a biodiversity vision for the Alps. As soon as the three organizations accepted to enter a partnership for the development of a biodiversity vision for the Alps, all decisions were jointly made. Then an internal orientation meeting was organized with staff from the Conservation Science Programme of WWF US (Holly Strand), in June 2001. Participants were people who would have been involved in the organization of the biodiversity vision workshop (from WWF, given that they were appointed as the lead of the process). During the orientation meeting, the template methodology for biodiversity vision was reviewed as well as the Alpine data already collected, and a work plan for how to proceed was developed. The date of the first workshop was set so to allow enough preparation time. The town of Gap in the French Alps was chosen as the location.

Five institutions provided technical support during the entire process:

1. WWF US with both the Conservation Science Programme and the Ecoregional Conservation Strategies Unit, which accompanied the Alpine process capitalizing on the experience made in several other ecoregions;
2. the Conservatoire Botanique National Alpin of Gap, France, which offered its GIS lab and assisted in all technical matters during the workshop in Gap in 2002;
3. the Ecology and Nature Protection Institute of the University of Vienna, Austria, which supported the initiative with data collection, analysis and GIS work, especially during the first part of the process (priority areas);
4. the Institut für Naturschutzforschung und Ökologie GmbH (VINCA), based in Vienna, Austria, which provided all GIS services during the second part of the process (connection areas);
5. the Alterra Institute, based in Wageningen, The Netherlands, which provided scientific and technical steering during the second part of the process (connection areas).

The objective of the Gap workshop was to identify the most important areas and macro-corridors for the biodiversity of the Alps and the urgent actions needed for the coevolution of nature and human activities in this region. Two main phases were then planned: the



definition of the areas important for the biodiversity of the Alps, and the preliminary identification of activities required for their conservation.

The biodiversity workshop in Gap was one of the key events to develop the biodiversity vision for the Alps. However, the process was not concluded at the end of the workshop but continued for about one more year (to fill in the gaps left at the workshop, to validate the results, to refine the maps). What follows is a brief description of the methodology used during the entire process.
The workshop, the first public event to develop the biodiversity vision for the Alps, lasted three days and was organized with plenary sessions and working sessions in groups. On the first day, after an introductory session, participants were divided into thematic groups, each for a different taxon or theme. Each group was provided with a base map of the Alps at a scale 1:500 000, several blank mylar sheets and a copy of the reference maps (forest cover, planned streets, etc.) Their task was to identify the most important areas for that taxon or habitat type. Their results for the different taxa were digitized overnight, overlaid one on top of the other and presented to the experts the following morning for validation. On the second day, the experts were divided into geographic groups, one for each subregion of the Alps (North West, South West, Central, North East and South East) and were asked to analyze and rank the areas, which had been identified through the overlay of the taxon maps. Their results were, once again, digitized and presented to the plenary the following morning. On the last day, the experts were asked to identify the corridors among the priority areas and to identify preliminary long-term goals for the priority areas themselves. Scattered throughout the three days was also an exercise to develop a vision statement for the Alps.
At the end of the Gap workshop most maps and urgent actions had been drafted. However, due to the absence of some experts and to the lack of time, some maps and some conclusions about urgent actions were incomplete. Thus, the effort of the following months was devoted to filling in the data gaps. The experts present in Gap were re-contacted, as well as other experts not yet involved. A first opportunity to revise draft results was given at the *ad hoc* workshop in Alpbach, AT, during the Forum Alpinum in September 2002. Other opportunities were given to smaller thematic groups.

During the Gap workshop all decisions made were recorded on specific. Thus, for each polygon drawn on a map, there existed a corresponding datasheet describing why that polygon was considered important by that group of experts. There was an attempt to fill in similar datasheets for any integration made to the first draft of the maps, but at times this was impossible. This means that for a limited number of polygons present on the taxon maps (the areas important for a specific taxon) there is now no corresponding datasheet. However, the detailed description of the priority areas compiled by Kai Elmauer in 2004 partly overcomes this lack of information. Indeed, when the data gaps were finally filled in and the final maps produced, two consultants were contracted to describe the priority areas. Kai Elmauer undertook the analysis of the biodiversity and of the threats and opportunities for conservation (see chapter 10), Dominik Siegrist undertook a socio-political analysis.

Data collection, scope and scale issues, GIS issues

The Alps are one of the best-studied high mountain systems in the world. However, synoptic attempts at studies covering the entire Alps are very few (Bätzing's demographic and socio-economic studies; the habitat suitability assessments for the Alps by the Large Carnivore Initiative for Europe; CIPRA's Reports on the State of the Alps; the demographic analysis of the Alps by the System of Observation and Information of the Alps). Information and data are mainly available on a national or subnational basis (for example Swiss cantons, Italian regioni, Austrian Länder, French départements, etc.). To overcome this obstacle, in 2001 the WWF European Alpine Programme started to collect the relevant and available GIS data on biodiversity and socio-economic issues for the entire Alps, and tried to harmonize into pan-Alpine layers those that were only available at national scale. To be collected, the data ought to fulfill the following requirements:

- the data set should include the whole Alpine region, defined as the area covered by the Alpine Convention
- the data set should be homogeneous
- the data set should be free of charge or cheap
- the data set should have a scale of 1:500 000.

Thus, only data available for the entire Alps were considered and transferred into a Geographic Information System (GIS) which was then used for the analyses of the biodiversity vision (for macro-corridors this is not always true as individual initiatives to identify corridors for subregions of the Alps were also taken into consideration). Table 2 gives an overview of the available data: namely, the reference layers described before).
A working scale of 1:500 000 was chosen, because it was possible to print the study area with a satisfying resolution on two A0 plots and to prepare all the working maps and mylars. Too many details would have disappeared using a smaller scale (e.g. the entire Alps on one A0 plot), while more plots would have been too bulky to work with had we chosen a more detailed scale.

The used projection was the same as CORINE Landcover: Lambert Equal Area Azimuthal with the parameters 9 and 48. All data sets with a different projection were reprojected to this projection.

Reference maps and data sources

At the workshop some maps were available to the experts as reference material. These maps were made available to all working groups in mylar form. Experts could use them while identifying the areas important for the various taxa and the major habitat types, and later when identifying the most urgent actions for each priority areas. Such maps had been prepared in the months preceding the workshop, and were at times used also after the workshop when experts were asked to fill in some of the gaps in the maps.

Table 2. Description of the reference maps used in the Gap workshop and of their sources.

DATA SET	SOURCES	DESCRIPTION
Base map	Corine, Pelcom, European Topic Center on Land Cover ETC/LC – EEA, Zukunft Biosphäre, Teleatlas, Digital Chart of the World, Alpine Network of Protected Areas ALPARC)	The base map was used as a background to allow a spatial orientation for the work with the mylars in Gap. It was created from different sources, showing the land cover classes, the 200m elevation isopleths, transport infrastructures (railways, motorways and major roads), political borders (countries and NUTS level 3 or 4), rivers, the borders of the Alpine Convention and the names of larger locations.
Bearded vulture	International Bearded Vulture Monitoring Nationalpark Hohe Tauern / EGS Austria	Polygons with the core and the potential areas of bearded vulture distribution.
Brown bear	IEA – Istituto Ecologia Applicata, Rome (I)	Environmental suitability surface with a spatial resolution of 250 m and polygons showing the known extent of occurrence.
Built-up areas	Slovenia: Corine Landcover Other: Teleatlas	Urban areas derived from the Teleatlas data set or Corine Landcover.
Butterflies	P. Hümer / Ferdinandeum, Innsbruck (AT)	Point data of endemic or endangered butterfly species distribution.

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At the end of the workshop a survey on the usefulness of these reference maps was conducted among the experts present. The top six maps which resulted most useful to the experts were the base map, the forest cover map (Fig. 5), the protected areas map (Fig. 9), the river/water map, the population density (Fig. 8) and the IBAs.

Methodology and rationale

The ecoregion conservation approach recommends a series of steps to develop the biodiversity vision. This template methodology was reviewed by representatives of ISCAR (i.e., the scientific community of the Alps) and of WWF and adapted to the specific features of the Alps.
Special attention was paid to the role of cultural landscape in the Alps, namely landscape originated several thousand years ago from the manipulation by humans and maintained such through traditional "soft" land uses such as extensive agriculture and grazing of local domestic breeds. More than 40% of the biodiversity of the Alps depends on this landscape (Grabherr et al., 2000), and some related species and habitat types are considered so important at European level that they are protected by EU legislation (see for example the Birds and the Habitat Directives and the objectives of the Natura 2000 Network). Unlike other ecoregions, where the biodiversity worth protecting is threatened by human intervention – in the Alps it was decided to attach great value to such cultural landscapes and to consider them among the typical natural habitats of the Alps

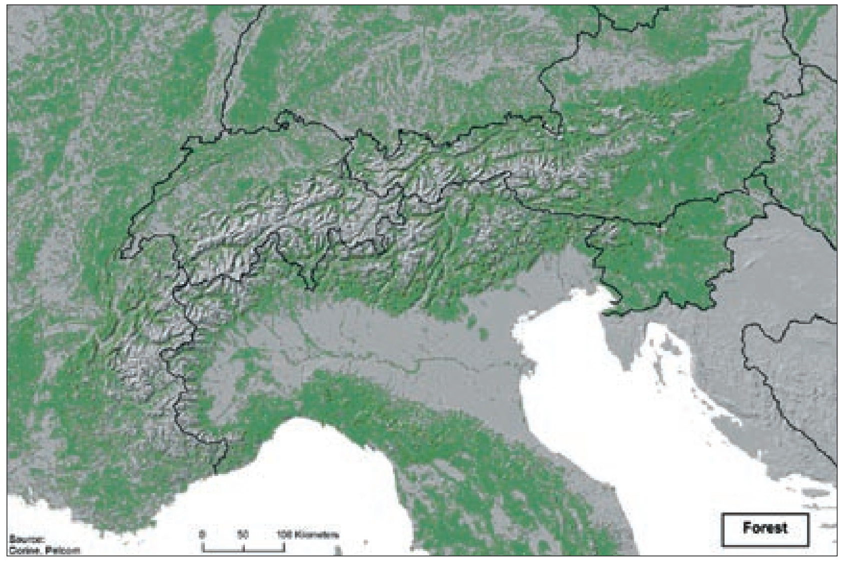

Fig. 5. Map showing the forest cover landscape in the Alps

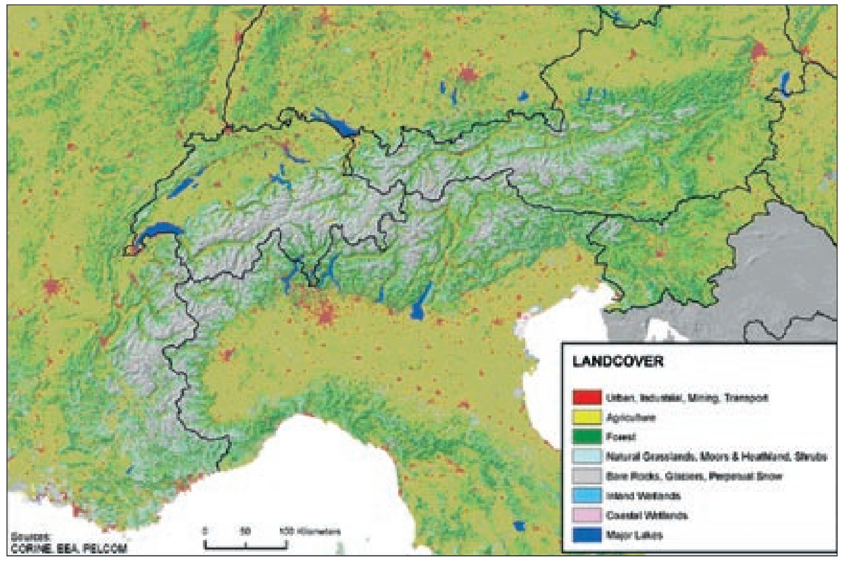

Fig. 6. Map showing the land cover in the Alps

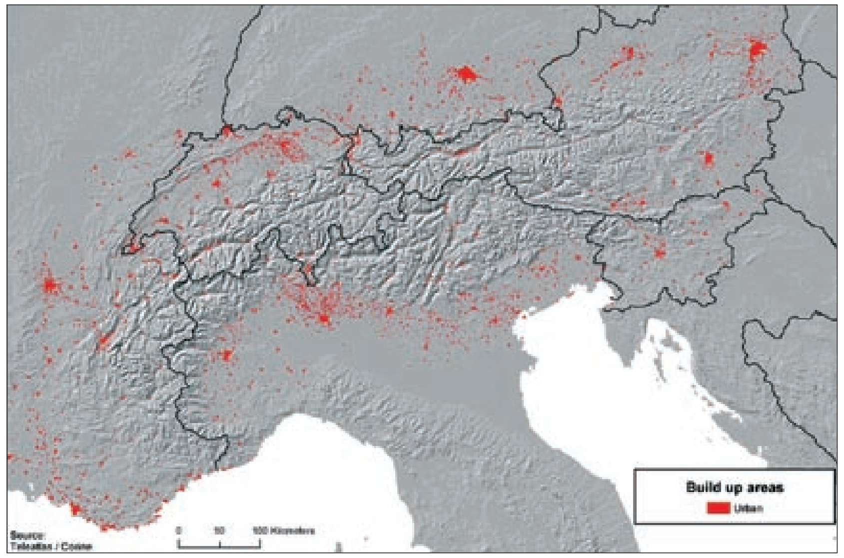

Fig. 7. Satellite image showing the lights at night in the Alps, corresponding to population density

Domestic breeds	Università degli Studi di Torino Dipartimento di Scienze Zootecniche (I) Monitoring Institute for Rare Breeds and Seeds in Europe (CH)	Polygons showing areas with endangered domestic breeds. This map was produced combining the submissions of three experts on domestic breeds in the Alps (Mr. Hans-Peter Grunenfelder-CH, Mr. Riccardo Fortina-I and Ms Marija Markes-SLO). The idea was to identify the areas where important, typical Alpine domestic breeds are still present, and to keep these areas into consideration when identifying urgent actions for conservation in the Alps.
Elevation (Figure 2)	Zukunft Biosphäre	Digital Elevation Model raster map with a spatial resolution of 200m. Additionally, a second map showing the 200 m isopleths was created.
Forest (Figure 5)	Corine Landcover Pelcom European Topic Center on Land Cover ETC/LC – EEA	Forest areas of the base map.
Golden eagle potential habitat	Zukunft Biosphäre	Raster map with spatial resolution of 250m showing a potential habitat surface for the golden eagle.
Golden eagle population density	Zukunft Biosphäre	Raster map with spatial resolution of 250m with a surface showing a population density model for the golden eagle.
Hunting activity in the southern (Italian) Alps	Istituto Nazionale per la Fauna Selvatica (National Wildlife Institute), Unione Nazionale Cacciatori Zona Alpi (National Union of Alpine Hunters), WWF Italy (data 2000)	Map showing the hunters density at regional level
Important Bird Areas (IBAs)	AT: Birdlife Austria[1] D: Birdlife Germany (NABU)[2] I: Birdlife Italy (LIPU) FL: Birdlife Liechtenstein SLO: Birdlife Slovenia (DOPPS) CH: Center Suisse de cartographie de la faune F : Muséum National d'Histoire Naturelle, Paris. Thanks also to the support and coordination of BirdLife International.	Polygons of the important bird areas. IBAs are key sites for conservation – small enough to be completely conserved and often already part of a protected-area network. They are characterised by one or more of the following points: * Hold significant numbers of one or more globally threatened species. * Are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species. * Have exceptionally large numbers of migratory or congregatory species. (www.birdlife.net) All IBA boundaries became fully available in mid-2003. Before that date, when digital boundaries of IBAs were not fully available, IBAs were represented on maps as dots (see for example AT) or not represented at all (see for example France).
Inland water	Corine Landcover, Digital Chart of the World	Map showing lakes and rivers. This map was combined with the river map.
Landcover (Figure 6)	Liechtenstein: Pelcom Switzerland: Switzerland land cover reclassified to CORINE level 2, European Topic Center on Land Cover ETC/LC – EEA Other: Corine Landcover	The landcover data set was assembled from different sources. Because of the different classifications of the input data, it was necessary to build a coarser, consistent legend. The result was a raster map with a spatial resolution of 250m showing 8 classes: Urban, industrial, mining, transport; Agriculture; Forest; Natural grassland, moors & heathland, shrubs; Bare rocks, glaciers, perpetual snow; Inland wetlands; Coastal wetlands; Inland waters.

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deserving protection (when hosting biodiversity). Besides contributing to conserving a distinct portion of biodiversity, this approach also helped to show to mountain communities that the biodiversity vision did not intend to work against them.

As for invasive species, it was originally decided to add their prevention or eradication as the fifth pillar of biodiversity conservation. However, it became soon obvious that the enunciation of this principle was redundant as it is already "nested" under the first three pillars. Despite its removal from the principles, the caution towards alien species in the Alps remains a concern.
The considerations made above were incorporated in a short document briefly outlining the methodology proposed to develop the biodiversity vision for the Alps. Before the first workshop this draft methodology was distributed to the experts that would participate.

The methodology included eight steps:

1) Delineate the ecoregion and identify the biogeographic subregions
2) Identify focal species for different taxa, key habitats as well as ecological processes that support Alpine biodiversity
3) Select taxon priority areas for each taxon
4) Select candidate priority areas for biodiversity as a whole based on taxon priority areas and priority areas for ecological processes
5) Evaluate habitat representation of candidate priority areas
6) Rank priority areas for biodiversity conservation
7) Identify important corridors among priority areas
8) Conduct a gap analysis for protected areas or other sites considered important.

These steps will be described in the following sections.

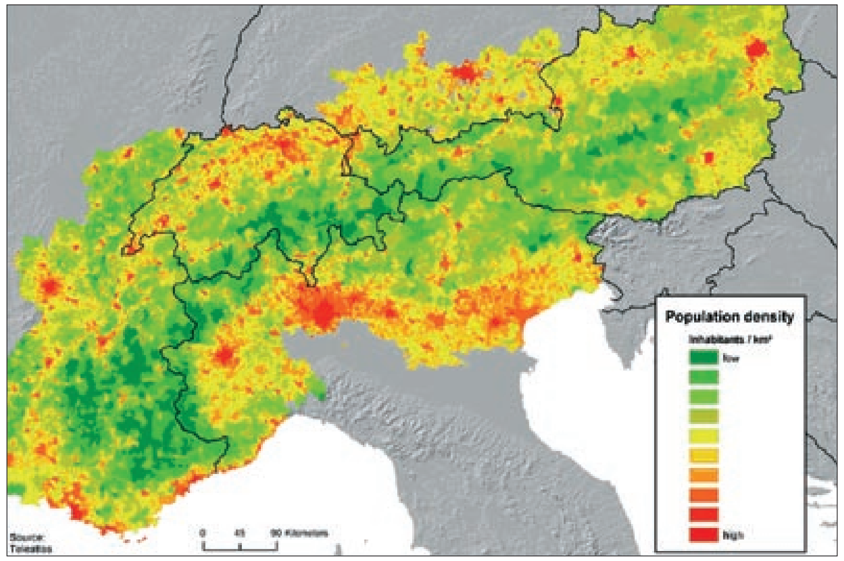

Fig. 8. Map showing population density in the Alps

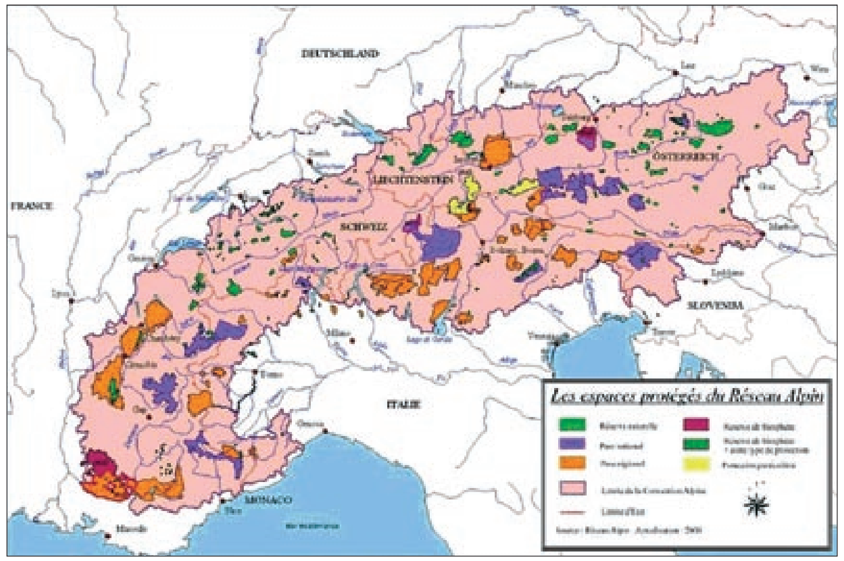

Fig. 9: Map showing the protected areas in the Alps

Lynx	IEA – Istituto Ecologia Applicata, Rome (I)	Environmental suitability surface with a spatial resolution of 250m and polygons showing the known extent of occurrence.
Major forest types of the southern Alps	WWF Mediterranean Programme, Rome (I)	Polygons with the major forest types of the southern Alps.
Night luminosity (Figure 7)	US Air Force Defense Meteorological Satellite Programme (DMSP) Operational Linescan System (OLS) US National Oceanic and Atmosheric Administration's National Geophysical Data Center	Raster map with a spatial resolution of 750m showing the nighttime visible lights. The lights are a direct indicator for human activity; dark regions show areas with low anthropogenic pressure.
Planned streets	WWF	Map showing inner Alpine, transalpine and Italian "legge obiettivo" street projects.
Population density (Figure 8)	Teleatlas	Inhabitants/km² on NUTS 5 level.
Protected areas (Figure 9)	The Alpine Network of Protected Areas (version: 2002)	Polygons showing nationals parks, regional nature parks, reservation areas and other areas under special protection.
Ramsar sites	UNEP – WCMC for the version available in 2002. www.ramsar.org for the new version used in 2006 for the gap analysis	Polygons showing Ramsar sites. The Ramsar convention is a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Remote areas	Department of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna (AT)	Model surface showing remoteness from infrastructure and built-up areas. Remote areas are unfragmented areas without direct human interference. This map was produced by Thomas Kaissl, University of Vienna. It is an indirect indication of where ecological and evolutionary processes still take place undisturbed in the Alps (lack of human interference means the opportunity for nature to take its course undisturbed).
Skiing areas (Figure 27)	ADAC Skiing Guide	Point data set of skiing areas in the Alps digitized by WWF showing a weighed combination amount of guest beds, lift capacity and length of ski runs.
Transport (Figure 26)	Slovenia: Digital Chart of the world Rest: Teleatlas	Map showing motorways, major roads, minor roads and railways.
Urbanization centers	M. Perlik / University of Bern (CH)	Polygons showing cities and urbanization centers. The map distinguishes between urbanization zones with a center in the Alpine region and centers outside.
Vegetation belts	By P. Ozenda and A.M. Tonnel of the Laboratoire Botanique of the University of Grenoble, 1984 (photo-enlarged to 1:500.000 from the original 1:2.250.000)	It shows the distribution of the vegetation types by elevation belts. • *Piedmont:* mesomediterranean, plain oak forests, pannonic, submontane oak-beech forests. • *Collinean belt:* western type (Quercus pubescens), eastern type (Ostrya carpinifolia), medioeuropean type (acidophilous oak forests), suprannonic type. • *Mountain belt:* outer beech forests, inner fir and spruce forests, inner pine forests. • *Subalpine belt:* outer type, inner type (cembro pine and larch). • *Alpine and nival belts:* on calcareous rocks, on siliceous rocks, glaciers).
Wolf (Figure 4)	IEA – Istituto Ecologia Applicata, Rome (I)	Environmental suitability surface with a spatial resolution of 250m and polygons showing the known extent of occurrence.

[1] Available after Gap.
[2] Including SPAs (Special Protection Areas).

Step 1: **Delineate the ecoregion and identify the biogeographic subregions of the Alps**

It was agreed that the boundaries of the Alps ecoregion would reflect the area of application of the Alpine Convention. By doing so, the initiative for the biodiversity vision of the Alps would benefit from the studies already produced under the umbrella of the Alpine Convention. Furthermore, there would be a policy instrument to eventually refer to for the implementation of the vision. The digital boundary of the Alpine Convention was received from the Network of Alpine Protected Areas and modified to address some minor inaccuracies.

As for biogeographic subregions, they help to ensure representation of habitats and species within priority areas (Goal 1 and 2 of biodiversity conservation, see 1.4), given that species composition of similar habitats in different subregions will vary. Various subregion classifications were available for the Alps in 2002, such as:

– Jean-Paul Theurillat (University of Geneva, CH) divided the Alps into a hierarchical system of 2, 3, 6, 8, 12, and 22 biogeographich divisions.
– Udo Bohn et al. (Bundesamt für Naturschutz, Germany) identified subdivisions of the Alps based on potential natural vegetation.
– Paul Ozenda (Laboratoire d'Ecologie Alpine, Université Joseph Fourier, Grenoble, 1988) divided the Alps into the *fringe Alps* (with seven biogeographic subdivisions) and the *inner Alps* (with two biogeographic subdivisions).

The systems are equally valid; it was decided to use the systems by Theurillat and Bohn because their data sets were readily available in electronic GIS format, while Ozenda's was not.

Step 2: **Identify focal species for different taxa, key habitats and ecological processes that support the Alps biodiversity**

Note: all scientific names of species refer to the period 2002-2003, when the focal species were identified and the maps produced. Since then, some species have been renamed; in some cases this is acknowledged in the text, in others it is not.

The Alps are characterized by a specific set of species, communities, habitats and processes, which should be preserved or restored as an important part of the ecoregion biodiversity and to maintain its ecological integrity. Ideally, a conservation strategy takes all species, communities, habitats and ecological processes into account to fulfill the goals of biodiversity conservation. However, due to limited resources and data, only a small set of species and key habitats can be considered. These are called *focal* species or habitats and they are representative of the region they belong to[1] (Miller et al. 1998). By conserving these species a whole array of other species, communities or habitat types will be conserved. Guidelines were provided to the experts for the selection of focal species.

Only focal taxa or habitats were considered for which data were available for the entire Alps, at the same scale and in a harmonized format. In other words, it was of the utmost importance to think at the scale of the entire Alps, and the chosen level of detail (minimum common denominator) had to allow comparison within the Alpine range. For this reason, scientific categories were simplified to adopt less detailed definitions (e.g., "forested areas" rather than different types of forests).

The main taxa or habitat types which were selected as focal are (see Table 3 for a full list and more details):

– Flora
– Mammals
– Birds
– Amphibians & Reptiles
– Invertebrates
– Freshwater habitat.

Within these taxa or habitat types a further selection was made for focal species of subsets of habitat types, as follows.

Mammals

Three subsets of mammal species were selected: large carnivores, large herbivores and medium-small mammals, each with the following focal species (or families), as decided by the experts of each group according to their representativeness of the Alps:

– For large mammals: bear (*Ursus arctos*), lynx (*Lynx lynx*) and wolf (*Canis lupus*)
– For large herbivores: chamois (*Rupicapra rupicpra*), ibex (*Capra ibex*) and red deer (*Cervus elaphus*)
– For medium and small mammals: otter (*Lutra lutra*), *Eptesicus nilssoni*, *Rhinofolidae*, *Microtus bavaricus*, *Apodemus alpicola*.

The experts produced maps for each of these three subsets of mammals, but then they were consolidated into only one map for all mammals (Fig. 11).

Birds

It was decided to base the bird layer on the IBAs, the Important Bird Areas identified by BirdLife International and its partners throughout the world. IBAs are the most important areas for birds according to a set of internationally agreed criteria and therefore represent a very advanced global vision for birds. In fact, rather than trying to start anew and identify focal bird species and then their priority areas, it seemed much more effective to embrace the results of the work already

[1] A *focal species* is a species which meets several of the following requirements/criteria and therefore makes it a good model for conservation of whole species assemblages (and of their habitat) (Miller et al. 1998):

Habitat criteria
1. Dependence on large areas to maintain viable populations / wide-ranging
2. Area sensitive / specialized habitat requirements
3. Dependence on rare, widely dispersed habitat

Life history criteria
4. Limited dispersal ability
5. Seasonal/daily population concentration
6. Large body or largest member of feeding guild
7. Reproductive specialization / low reproductivity or fecundity
8. Specialized dietary requirements
9. Climatic sensitive

Other criteria
10. No invasive species
11. Major life history traits and distribution data should be known about the species (e.g. area requirements)

undertaken by BirdLife and widely recognized in Europe and worldwide (in Europe IBAs are the basis for the identification of sites according to the Birds Directive). The collaboration of BirdLife International and of the national organizations of the Alpine countries affiliated to it (DOPPS for Slovenia, LIPU for Italy, NABU for Germany, SVS for Switzerland) was therefore sought. They all offered support and the digital boundaries of the IBAs already identified in the Alps.

Besides this valuable basis provided by IBAs, for Austria, Germany and Switzerland some bird species typical of the Alps were also selected by the group of bird experts as additional focal species. Such species may have not been considered during the identification of IBAs because they did not trigger IBA criteria, but still deserved to be taken into account for the Alps. An example was the need to identify areas in Germany for capercaillie. The full list of these species is:

– For the *Anatidae* family: Common Merganser (*Mergus merganser)*
– For the *Phasianidae* family: Rock Partridge (*Alectoris graeca saxatilis*)
– For the *Tetraonidae* family: Western Capercaillie (*Tetrao urogallus*)
– For the *Charadridae* family: Eurasian Dotterel (*Charadrius morinellus*, now called *Eudromias morinellus*)
– For the *Scolopacidae* family: Common Sandpiper (*Actitis hypoleucos*)
– For the *Upupidae* family: Eurasian Hoopoe (*Upupa epops*)
– For the *Picidae* family: White-backed Woodpecker (*Dendrocopos leucotos*), Grey-faced Woodpecker (*Picus canus*) and Three-toed Woodpecker (*Picoides tridactylus alpinus*)
– For the *Turdidae* family: Bluethroat (*Luscinia s. svecica*), Blue Rock Thrush (*Monticola solitarius*) and Rufous-tailed Rock-Thrush (*Monticala saxatilis*)
– For the *Fringillidae* family: Citril Finch (*Serinus citrinella*).

The IBAs and the areas important for the other focal bird species were mapped onto two different layers, but then merged into one overall bird layer (Fig. 12)

Amphibians and reptiles

Five are the focal species identified for amphibians.

– For the *Salamandridae* family: Alpine Salamander (*Salamandra atra aurorae*), *Salamandra atra ssp*. (not yet described in 2002, but now known as *Salamandra atra pasubiensis*), Lanza's Salamander (*Salamandra lanzai*) and Alpine Newt (*Triturus alpestris*, neotenic or paedomorphic)
– For the *Plethodontidae* family: Strinati's Cave Salamander (*Speleomantes strinati*).

Three are the focal species identified for reptiles.

– For the *Lacertidae* family: Horvath's Rock Lizard (*Lacerta horvathi,* now called *Iberolacerta horvathi*) and Viviparous Lizard (*Zootoca vivipara carniolica*)
– For the *Viperidae* family: Orsini's Viper (*Vipera ursinii*).

Insects

Originally, two working groups on invertebrates had been planned, one on terrestrial species and one on aquatic ones. However, aquatic invertebrates could not be taken into consideration as not enough data were collected in advance and not enough experts were available for the workshop (some consideration of aquatic invertebrates are included in the freshwater habitat theme). For terrestrial invertebrates, only butterflies and beetles had to be considered, the only groups of species for which data were available at the same scale for the entire Alpine range. Thus the invertebrates layer now only covers "insects" and includes the following orders:

– butterflies *(Lepidoptera)*
– beetles *(Coleoptera)*.

Beetles and butterflies were mapped onto two different layers, but then merged into one overall insect layer (Fig. 14).

Freshwater habitat

Originally, a working group on fish and one on aquatic invertebrates had been thought of. However, given that it was difficult to find experts and data for these two themes covering the entire Alps, it was decided to merge them into one theme called "freshwater habitat". The presence of fish or aquatic invertebrates species, as known by the freshwater experts, was an indirect factor for the identification of the freshwater habitats to select.

Ecological processes

Ecological processes[1] include water cycle, migrations, natural discharge river flow, climate change, etc. As ecological processes mostly are not adequately defined and their distribution is not mapped, they could only be considered indirectly. Important freshwater habitats, for example, partly incorporate intact flood regimes; migration routes of mammals and birds have partly been considered when including vertical gradients within the boundaries of the priority areas, and an analysis of remote areas in the Alps (Kaissl 2002) indicates areas with intact geological processes.

Step 3: **Select taxon priority areas for each taxon**

For each taxon and key habitat, the most important areas in the Alps were selected. It should be highlighted that the areas were identified as "most important" only if they really had an importance at pan-Alpine level and all members of the taxon group agreed. This worked as a "filter" and prevented areas of local or regional importance from being mapped, which would have altered the results and defeated the purpose of the exercise.
Specific criteria were listed for this purpose by the international groups of experts gathered for the 3-day workshop in Gap (on the first day experts were divided into working groups according to taxa and habitat types). The experts used these criteria to identify the areas in the Alps, which are most important for the respective taxa/key habitat types, taking into consideration the area requirements of relevant species (the areas should be large enough to ensure the long-term viability of the species' (meta-populations). As already described, within the taxon groups of mammals, birds and insects, subtaxon maps were defined and later merged into only one map for each taxon.
The areas important for the taxa or habitat types were hand-drawn on mylar sheets which had previously been overlaid onto a base map[2] of the entire Alpine range (scale 1: 500 000), and then digitized into a Geographic Information System (GIS). The digital maps were thus presented to the same experts and validated on the spot, allowing an immediate correction of potential mistakes.
A datasheet was filled out for each taxon area or habitat area identified (i.e., for each polygon drawn on the map), which provided information about the area itself.

[1] Examples of ecological processes are: Important migration routes of birds, mammals, etc. (including seasonal movements of animals), geological processes (avalanches, mud and rock slides), flood regimes, fire (naturally occurring), etc.

[2] The basemap shows landcover (8 classes – from CORINE), boundaries (Alpine Convention, Nations, NUTS levels 3 and 4 – from Teleatlas), transport systems (railroads, motorways, major roads – from Teleatlas) and rivers (from the Digital Chart of the World).

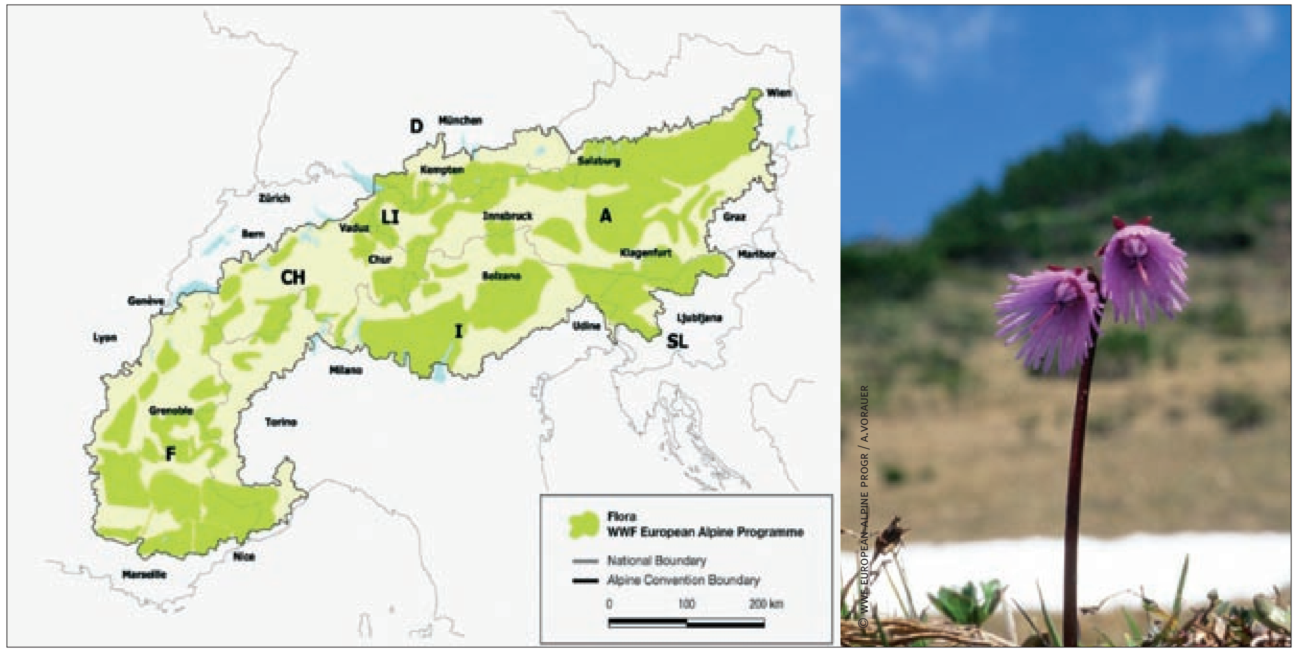

Fig. 10. Areas important for flora in the Alps.

Missing information for certain species, habitat and/or countries was subsequently incorporated during an extensive review process after the workshop.
In the following paragraphs are the descriptions of the criteria used for the identification of the areas most important for each taxon or habitat type (flora, mammals, birds, amphibians and reptiles, insects and freshwater habitat).

Flora

The map of areas important for flora in the Alps was drawn (Fig 10).

The criteria used to identify areas important for flora in the Alps are (among these criteria there are some which still reflect the original focus on vegetation):
– Richness of endemic species
– Large forest blocks
– Distinct dry areas
– Alpine rare species
– Areas with particular ecological phenomena important for flora (i.e., glacier forelands, peatbogs).

Even if the flora map may have been constructed with slightly different criteria for the western and the eastern Alps, the result are reasonable and reflect the actual status of flora and vegetation in the Alps. For example, the area in Switzerland roughly corresponding to the Gotthard and not considered important for flora at pan-Alpine scale is plausible given that this is a transition area between eastern and western Alps and a rain barrier. Relict flora species are still found in the western Alps, where priority areas for flora have been identified in smaller polygons, while larger forest blocks are still found in the eastern Alps, where priority areas for flora/vegetation have been identified in larger polygons (Wohlgemuth, personal communication).

Mammals

The consolidated map of areas important for mammals in the Alps was drawn. There also were individual maps of areas important for the three mammal sub-taxa (large carnivores, large herbivores, medium-small mammals) (Fig 11).

The experts worked in three sub-groups (large carnivores, large herbivores and medium/small mammals). The three layers thus created were merged into one. Each sub-group developed different criteria for the different sub-taxa, as they deemed appropriate.

For large carnivores, areas were selected as important if they were areas where the species currently reproduced, or could naturally reproduce within the next 10 years, or where the individual countries were planning to reintroduce them.

For large herbivores, areas were selected as important if they held all three focal species, if they had optimal or core habitat for some of the species, if they were important for habitat protection and restoration (e.g., areas overgrazed by red deer) and if they were areas for endemism (see area for *Rupicapra r. cartusiana*).

For medium and small mammals, areas were selected as important if the focal species were currently found there.

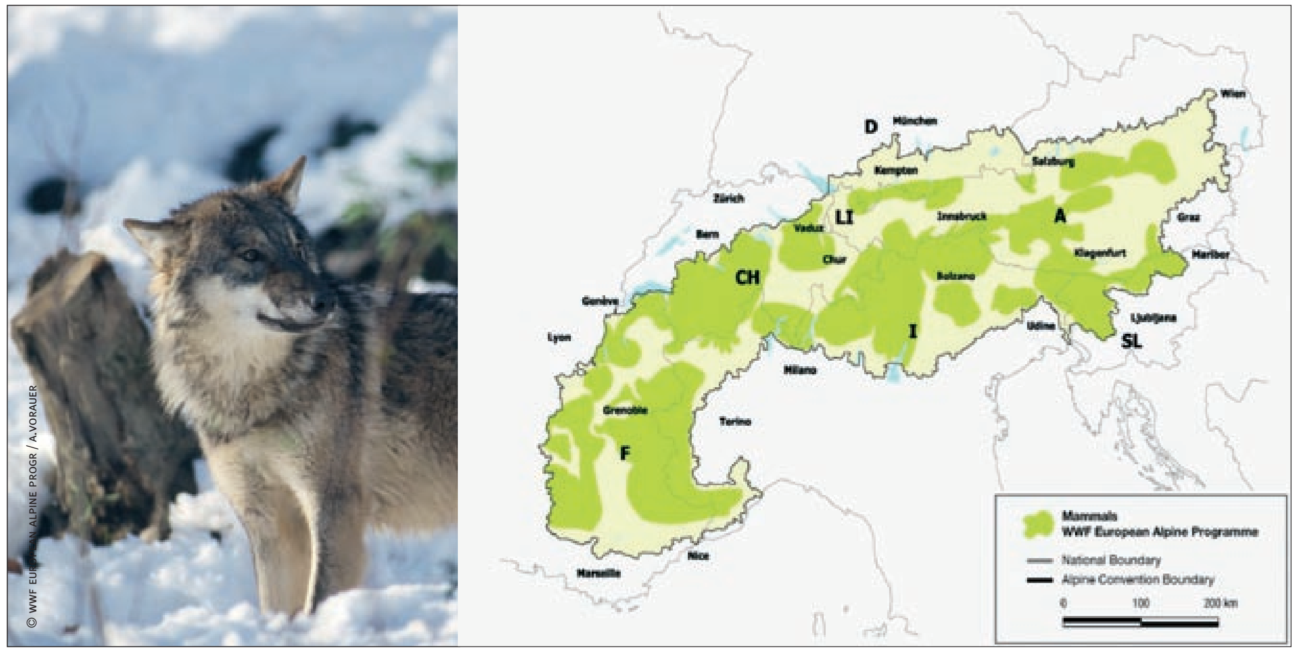

Fig. 11. Areas important for mammals in the Alps

Birds

The consolidated map of areas important for birds in the Alps was drawn (Fig 12). There also were individual maps of the IBAs and of the areas important for selected species of focal birds.

IBAs were identified according to three main criteria (see www.birdlife.org):
– They hold significant numbers of one or more globally-threatened species

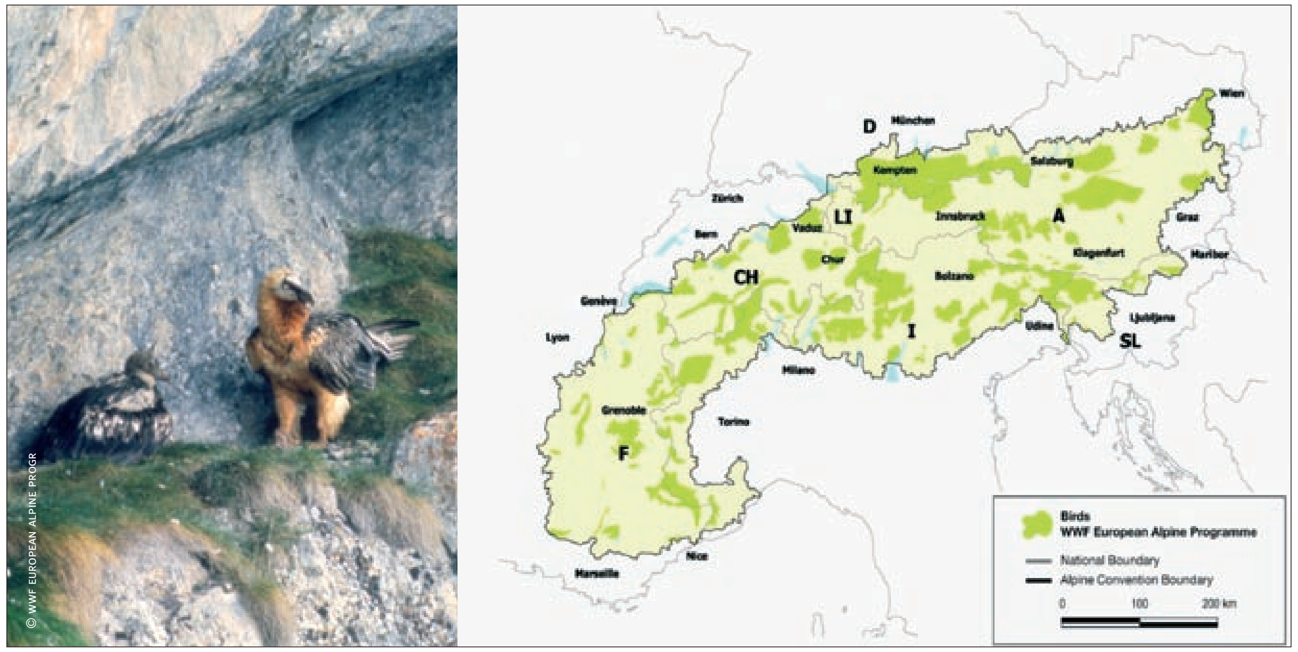

Fig. 12. Areas important for birds in the Alps

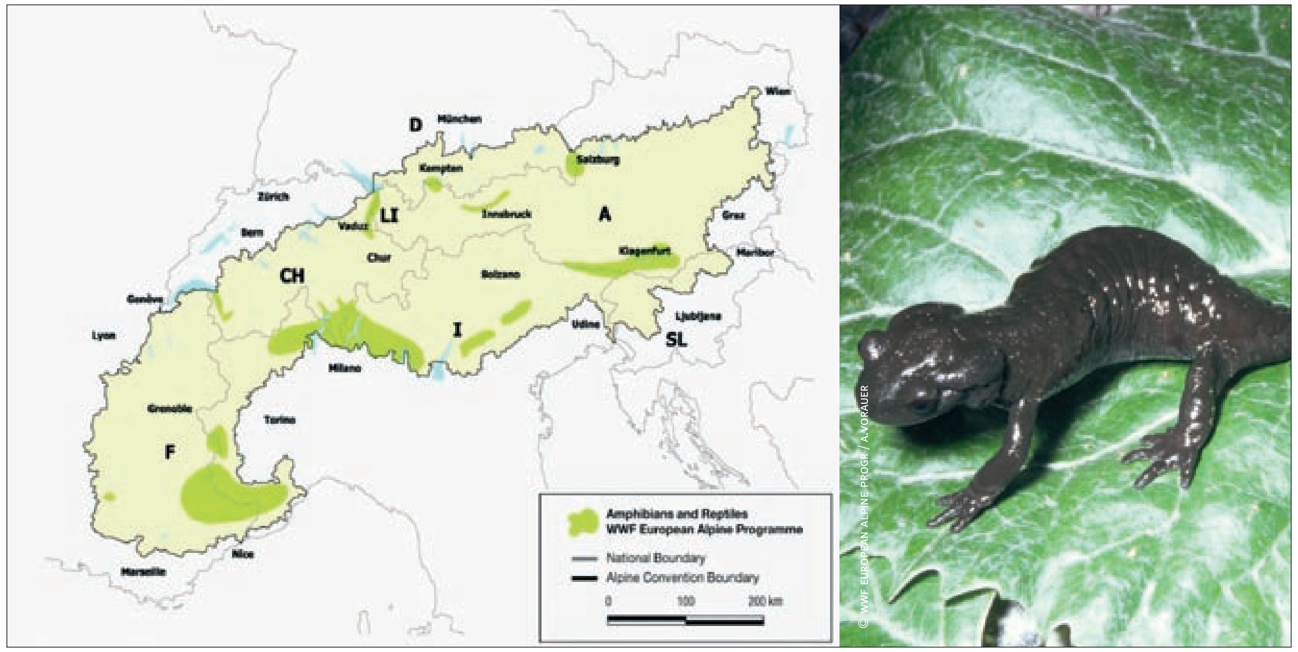

Fig. 13. Areas important for amphibians and reptiles in the Alps.

– They are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species

– They have exceptionally large numbers of migratory or congregatory species.

In addition, as already explained, BirdLife representatives and other bird experts of the Alps identified the aspects of birds biodiversity not already covered by the IBAs programme and proposed integrations for some countries of the Alps. Thus, for the selected number of bird species already listed, important areas in the Alps were also added to the layer of IBAs. This, however, was not done for all Alpine countries but only for Austria, Germany and Switzerland.

Amphibians & Reptiles

The map of areas important for amphibians and reptiles is found was drawn (Fig 13).

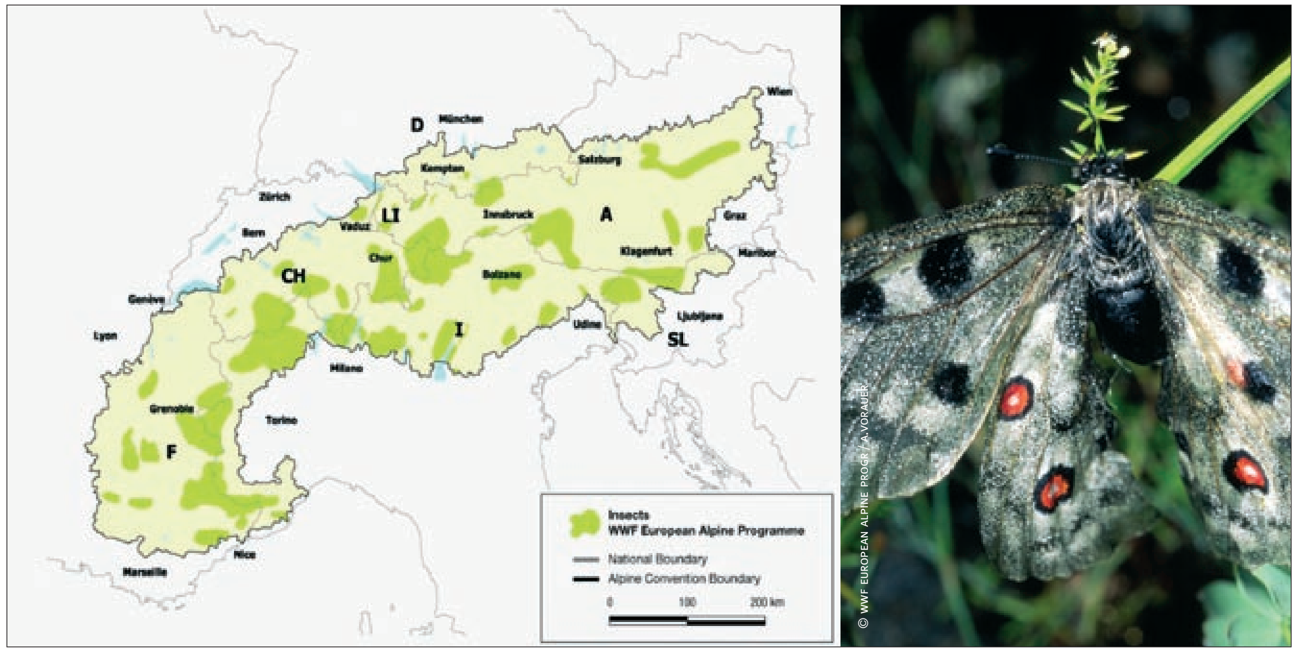

Fig. 14. Areas important for insects in the Alps

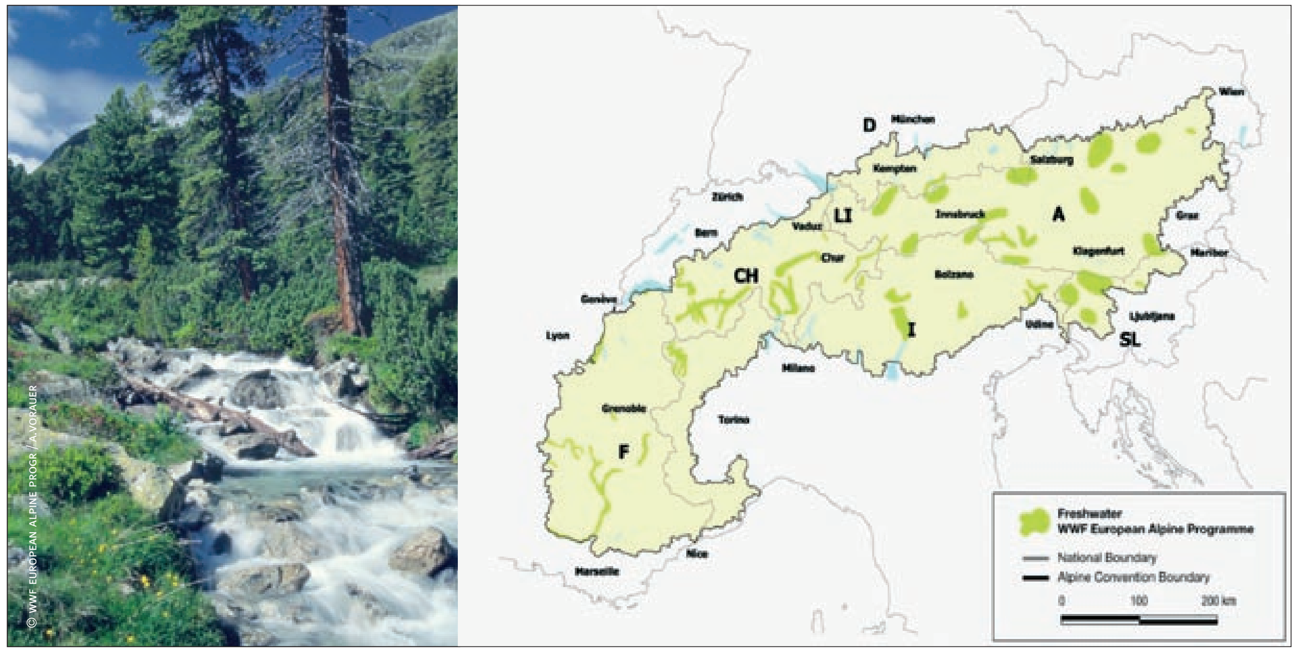

Fig. 15. Areas important for freshwater habitat in the Alps.

Areas of the Alps were identified as important for amphibians and reptiles if they host the focal species (including endemic and IUCN Red List species), if they host species richness (more than one species in the same place), and if they host ecological and evolutionary phenomena.

Invertebrates

The consolidated map of areas important for insects was drawn Individual maps for the two sub-taxa (beetles and butterflies) and for the different criteria are also available (Fig 14).

Areas of the Alps were selected as important for insects if they represented endemic centers for butterflies and beetles (i.e., centers of endemism), or biodiversity centers for butterflies (i.e., areas with several species).

Freshwater habitat

The map of areas important for freshwater habitat was drawn (Fig 15).
Areas of the Alps were selected as important for freshwater habitat if they represented remaining, intact rivers with a relatively natural floodplain, or if they were natural or semi-natural lower river stretches in valley bottoms (as opposed to upper stretches in the high mountains). The presence of certain invertebrate or fish species was an indirect indicator for intact rivers and floodplains and for natural or semi-natural river stretches.

Table 3: Summary of the criteria and the focal species used to identify priority areas for taxa and habitat types in the Alps.

Taxon / key habitat	Focal species	Criteria	Remarks
FLORA		1.Endemic species richness 2.Large forest blocks 3.Distinct dry areas 4.Alpine rare species 5.Particular ecological phenomena (i.e., glacier forelands, peatbogs)	
MAMMALS A. Large carnivores	• Bear (Ursus arctos) • Wolf (Canis lupus) • Lynx (Lynx lynx).	1.Areas where focal species currently reproduce 2.Areas where focal species can naturally reproduce within the next 10 years 3.Areas where individual countries want to reintroduce focal species within the next 10 years.	
B. Large herbivores	• Chamois (Rupicapra rupicapra) • Ibex (Capra ibex) • Red deer (Cervus elaphus).	1.(Focal) Species richness 2.Areas with optimal or core habitat for focal species (may need restoration first) 3.Areas important for habitat protection and restoration in relation to focal species 4.Area of endemism (see Rupicapra r. cartusiana).	
C. Small / medium mammals	• Otter (Lutra lutra): localized distribution, good habitat indicator, umbrella species • Eptesicus nilssoni: only bat typical for the Alps • Rhinolophidae (the whole family): localized distribution (in valleys up to 1000m), good habitat indicator, important for conservation • Microtus bavaricus: endemic • Apodemus alpicola: endemic	1.Known current distribution of focal species	
BIRDS IBAs		Important Bird Areas (IBA)	
Focal bird species for the Alps which did not trigger IBA criteria	• Mergus merganser • Alectoris graeca saxatilis • Tetrao urogallus • Charadrius morinellus (now called Eudromias morinellus) • Actitis hypoleucos • Upupa epops • Dendrocopos leucotos • Picus canus • Picoides tridactylus alpinus • Luscinia s. svecica • Monticola solitarius • Monticola saxatilis • Serinus citrinella	Additional areas of high biodiversity value for focal species	For Italy, France, Liechtenstein and Slovenia, only IBA sites were used
REPTILES AND AMPHIBIANS	• Salamandra atra aurorae • Salamandra atra ssp. (not yet described in 2002 but now known as Salamandra atra pasubiensis) • Salamandra lanzai • Triturus alpestris (neotenic or paedomorphic) • Speleomantes strinatii • Lacerta horvathi (now known as Iberolacerta horvathi) • Zootoca vivipara carniolica • Vipera ursinii	1. Areas with endemic species 2. Areas with species listed in the IUCN Red List 3. Areas with ecological and evolutionary phenomena 4. Areas with focal species 5. Areas with species richness	
INSECTS	• Butterflies (Lepidoptera) • Beetles (Coleoptera)	Endemic centers for butterflies and beetles Biodiversity centers for butterflies and other species (this layer may be regionally inconsistent)	Butterflies are among the best-known invertebrate groups, the overview about endemic species in the Alps is quite good and the difference in the data quality in the different regions is small.
FRESHWATER HABITAT		1. Remaining, intact rivers with floodplains 2. Lower stretches in river valleys (as opposed to stretches upstream in the high mountains or in river canyons), when in natural or semi-natural status (even if after renaturation).	

Step 4: **Select candidate priority areas for biodiversity as a whole based on taxon priority areas and priority areas for ecological processes**

All the maps of most important areas for taxa and habitat types were then overlaid through the GIS. From the overlay, the areas most important for biodiversity as a whole can be identified (i.e., the areas with and around the maximum overlap of areas most important for taxa and habitat types).

This was done a first time during the Gap workshop and preliminary priority conservation areas were identified. However, given that data gaps still existed in the database and that the experts groups were not complete, those results could not be considered final. A second overlay of taxon and habitat maps was undertaken (Fig. 16) when all the data gaps were filled in, about one year later. At this point, new priority conservation areas were also identified (Fig. 17).

Before agreeing on this new, final overlay, a discussion was held on the intrinsic value assigned to each layer. In particular, it was pointed out that simply overlaying the different layers without assigning different weights implied giving each layer the same value, even though some may represent taxa much richer or numerous in species than others. This may have sounded odd considering that there existed three layers for vertebrates (mammals, birds, reptiles and amphibians), only one each for invertebrates (by far the largest majority of animal species) and flora/vegetation, and only one for everything to do with aquatic species or habitat types (freshwater habitat).

Thus, a sensitivity analysis was conducted, assigning different weights to different layers and counting the existing sub-taxon maps (for mammals and insects) as separate layers. The resulting overlay did not change significantly, therefore it was decided to consider one layer for each taxon and to assign the same value to each one of them.

Also, the remote area layer was assigned the same value as the taxon layers and a new overlay was produced including it as well. Also in this case the results did not change significantly, however it was decided not to consider remote areas as important to biodiversity, given that often they are mountain peaks covered in ice and rocks, thus not really relevant for biodiversity. However, the remote area layer was used as a reference map during the delineation of the priority area boundaries (see criteria below) and as a proxi for ecological processes.

Having agreed on assigning the same weight to each layer, the boundaries of the priority conservation areas were identified according to these criteria:

1. Include within the boundaries of a priority area all areas where a minimum of 4 taxon/habitat priority area layers overlap (areas of maximum overlap of 4 or 5 layers represent the *core* of priority areas)
2. Include within the boundaries of a priority area also areas with an overlap of 3 or 2 layers, when these are adjacent to areas with an overlap of 4 or 5 layers
3. Include within the boundaries of a priority area also intact floodplain regions should there be a river nearby (whether or not the river is part of the freshwater priority area layer), and intact river corridors (even without floodplain)
4. Include within the boundaries of a priority area as many remote areas as possible, when they are adjacent to areas of great taxon overlay
5. Include within the boundaries of a priority area as much vertical gradient as possible
6. Consider the area requirements of the focal species present for the size of the priority area
7. Consider the potential of an area, not only the current state (addressing restoration as well as conservation)
8. Draw rough boundaries at a scale of 1:500 000, which will have to be verified at a more detailed scale during a landscape level analysis.

The boundaries of the priority areas were drawn by a small, international group of landscape ecologists directly on a base map of the Alps showing also the overlay (scale 1: 500 000), and then digitized. It should therefore be underlined that such boundaries are an approximation and are meaningful only at the scale at which they were identified (ecoregional scale).

Furthermore, it should be remembered that the overlay comes from other "source" maps (the taxon maps) which themselves had been drawn at a very coarse scale: the caution about the approximation of the boundaries of the priority areas could therefore not be more appropriate.

Thus the rough boundaries of the priority areas draw the attention to specific areas of the Alps where it will be worthwhile to conduct a more detailed (landscape) analysis on a regional or local scale. This subsequent phase – which is not part of the current process - will have to take place later on and will have to include the involvement of local interested parties (authorities, experts and communities).

To reflect the approximation of the boundaries, experiments with different graphics were conducted, in an attempt to draw the reader's attention to the general location of the priority areas and not to the specific boundaries.

A revision of the boundaries is also being partially undertaken through the identification of the connection areas of the Alps: some local experts gave indications on which areas should be enlarged and why, or should be connected to others.

Twenty-four priority areas for the conservation of biodiversity in the Alps were finally identified. The final list is found in Table 4.

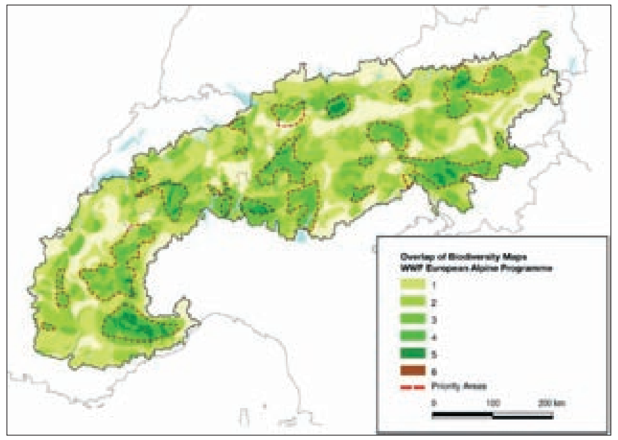

Fig. 16. Final overlay of the areas important for the different taxa and habitat types, 2003.

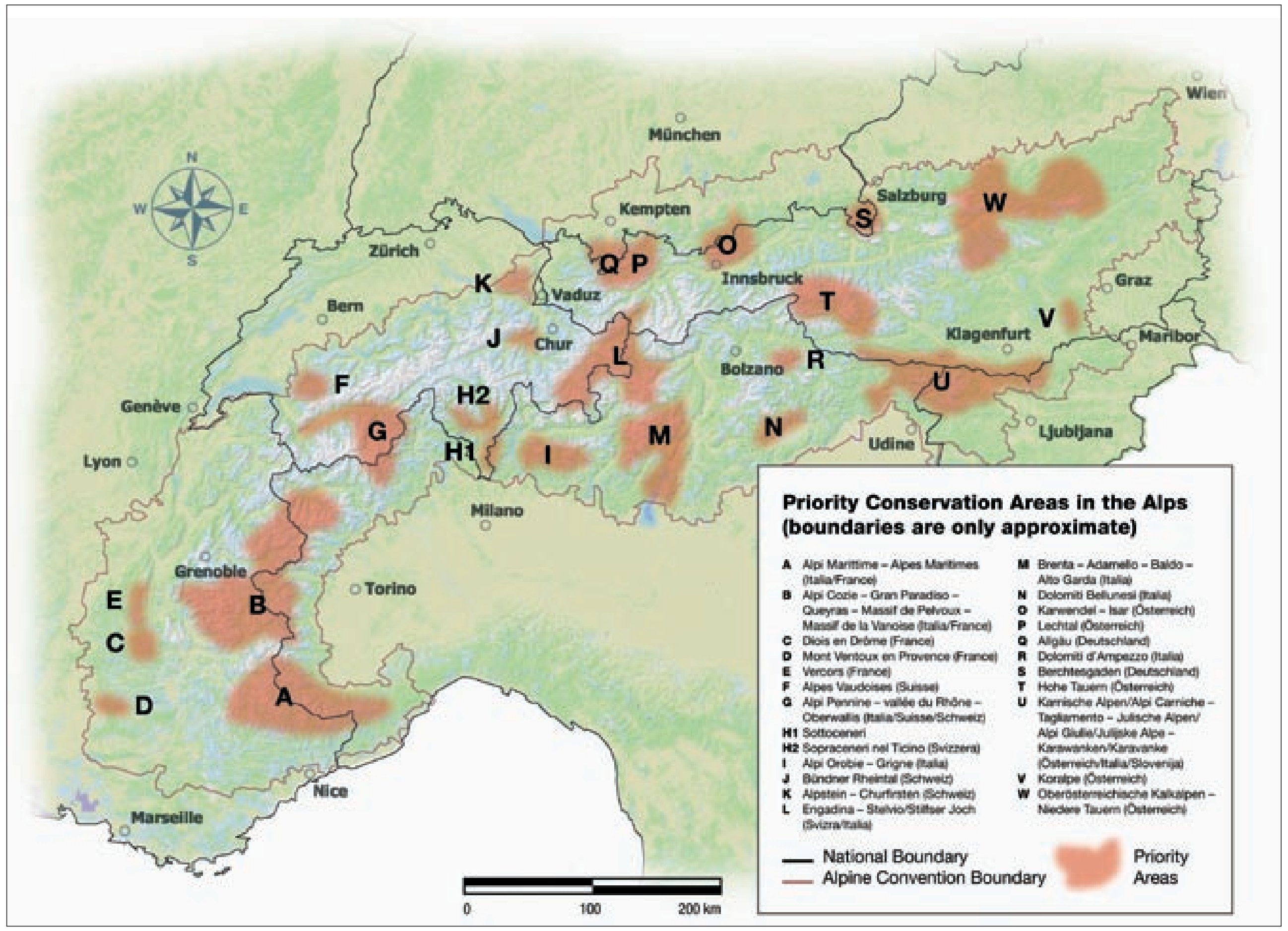

Fig. 17. Final priority conservation areas, 2003. The map on top shows the boundaries of the priority areas over the taxon overlay; the map on the bottom shows only the priority areas on a base map of the Alps.

A synthesis of the statistics of priority areas indicates that priority conservation areas cover about 24% of the Alps territory (about 44,450 km²). On average priority areas are 1,852 km², with a minimum surface of 226 km² (area J, Bündner-Rheintal) and a maximum surface of 7,268 km² (area B, Alpi Cozie-Gran Paradiso-Queyras-Massif de Pelvoux-Massif de la Vanoise). These statistics should however be considered with caution given that they refer to boundaries which are approximate themselves.

Ecological and evolutionary processes deserve a side note. As already stated, they are difficult to identify and to map, and – in spite of several attempts and requests to experts – they were never formally and successfully tackled in the biodiversity vision for the Alps. Nonetheless, they are extremely significant for the ecological integrity of the Alps, and are an essential component of biodiversity conservation: a biodiversity vision which does not take ecological and evolutionary processes into consideration is a flawed and incomplete one. Thus, indirect ways to incorporate such processes into the identification of priority conservation areas had to be devised:

1) Remote areas are areas relatively unfragmented and undisturbed. It can therefore safely be assumed that in these areas the typical ecological and evolutionary processes (whatever they are) can take place unimpaired. As a consequence, by including remote areas whenever possible within the boundaries of priority areas, the ecological and evolutionary processes present in the remote areas become incorporated into the priority areas.
2) Several processes occur along vertical gradients, for example: seasonal migrations of certain large herbivores or daily migrations of certain bird species, slope dynamics (avalanches, land slides), water regime (from glacier to stream) and adaptation to climate change. Thus, by including as much vertical gradient as possible within the boundaries of the priority areas the permanence of these processes is eased.
3) Several ecological processes are related to the hydrological cycle. By including floodplains and river corridors within the boundaries of the priority areas, such processes stand a higher chance to be conserved. Furthermore, some priority areas are identified thanks to the contribution of the freshwater layer, which maps the areas most important for intact rivers and floodplains.
4) Other processes like continental-scale migrations (e.g., birds), natural recolonization of areas from where species had previously been eradicated (large carnivores) and species dispersal can be assured through the identification and subsequent conservation and restoration or main connection areas, or through the implementation of ad hoc land and resources management measures.

Table 4. Final list of the priority conservation areas of the Alps. Names of priority areas are expressed in the languages of the countries in which they are located. This list could be revised in future years, i.e. PCAS in Trentino region.

Name of priority area	Location	Notes
A. ALPI MARITTIME – ALPES MARITIMES	Italia/France	Includes Alpi Marittime and Mercantour parks.
B. ALPI COZIE - GRAN PARADISO - QUEYRAS - MASSIF DE PELVOUX - MASSIF DE LA VANOISE	Italia/France	In the Cotian Alps area, great example of larch forest is also included. Note that Orsiera Regional Park is very near this priority area and is a suitable area for black grouse. It includes river corridors SW of Aosta (migratory pathways) and elevation gradients.
C. DIOIS EN DRÔME	France	
D. MONT VENTOUX EN PROVENCE	France	1.Known current distribution of focal species
E. VERCORS	France	
F. ALPES VAUDOISES	Suisse	
G. ALPI PENNINE - VALLÉE DU RHÔNE - OBERWALLIS	Italia/Suisse/Schweiz	*Catchment area. It Includes Rhône, Zermatt, Mt Rosa, Val Sesia, Val d'Ossola.* *Alpine endemisms and valley.* *Old Alpine traditions. Large townships (also carfree). Large ski resorts (Zermatt, etc).* *Upper Rhône also includes Mediterranean species.* *Note that the Aletsch region was not included even though it is relatively important. But it does not show up in the taxon layers, only in the remote area layer.*
H1. SOTTOCENERI - COLLINE COMASCHE - ALTO LARIO	Svizzera/Italia	It includes Val Maggia. Island of calcareous among gneiss. Several small townships
H2. SOPRACENERI NEL TICINO	Svizzera	Floodplain of granitic, crystalline catchment. H1 and H2 were purposely kept separate but under the same common "name" because they are different enough biogeographically, and yet both part of the same Ceneri complex.
I. ALPI OROBIE - GRIGNE	Italia	
J. BÜNDNER RHEINTAL	Schweiz	
K. ALPSTEIN - CHURFIRSTEN	Schweiz	*The western portion includes bogs.*
L. ENGADINA - STELVIO/STILFSER JOCH	Svizra/Italia/Österreich	It includes: Upper Engadin (Oberengadine), Lower Engadin, Val Venosta, Stelvio/Stilfser Joch (also important for bears).
M. BRENTA - ADAMELLO - BALDO - ALTO GARDA	Italia	*Presence of bear.*
N. DOLOMITI BELLUNESI	Italia	
O. KARWENDEL - ISAR	Österreich/Deutschland	
P. LECHTAL	Österreich	
Q. ALLGÄU	Deutschland/Österreich	
R. DOLOMITI D'AMPEZZO	Italia	
S. BERCHTESGADEN	Deutschland/Österreich	
T. HOHE TAUERN	Österreich	
U. KARNISCHE ALPEN/ALPI CARNICHE - TAGLIAMENTO - JULISCHE ALPEN/ ALPI GIULIE/JULIJSKE ALPE - KARAWANKEN/KARAVANKE	Österreich/Italia/ Slovenija	
V. KORALPE	Österreich	
W. OBERÖSTERREICHISCHE KALKALPEN - NIEDERE TAUERN	Österreich	It includes: Niedere Tauern, Enns Valley, Kalkalpen.

Step 5: **Evaluate habitat representation of candidate priority areas**

The evaluation of habitat representation is important because it ensures that all the characteristic natural communities of the ecoregion are actually represented in the selected priority areas. Communities depend on habitat types; habitat types depend on biogeographic subregions, which in turn depend on substratum, elevation and climate conditions.

Of the available divisions of the Alps into sub-regions, two were selected to check for representation of the priority areas: biogeographic divisions according to Jean-Paul Theurillat, University of Geneva and natural potential vegetation according to Udo Bohn et al., Bundesamt für Naturschutz. Within the Theurillat system, the division in eight subregions was used to test for representation. Within the Bohn's system, natural potential vegetation is an interesting and significant indirect measure for biogeographic subregions, as vegetation (i.e., vegetation communities) is heavily influenced by climate, elevation and substratum, and in turn influences the natural animal communities.

When the analyses of priority areas coverage versus the distribution of biogeographic subregion and potential natural vegetation were run, it became obvious that one particular subregion was underrepresented.

During the delineation of the boundaries of priority areas, the landscape ecologists proposed that – if a subregion was not sufficiently represented by the priority areas already identified – one of two options should be considered:

1) enlarge an existing priority area to cover the underrepresented subregion (preferable option)
2) create a new priority area choosing an area with an overlap of at least three taxon layers.

Given that the underrepresented habitat discovered during the analyses was not adjacent to any existing priority area, a new one was identified in France. With this addition, all major habitat types according to both sets of subregions are adequately represented by the priority areas identified.

For the biogeographic divisions of the Alps, an average of 24.6% of each sub-division is included in priority areas, with a minimum of 15.3% for Maritime Alps/ Haute Provence (AMA/PRO) and a maximum of 42% for Piedmont (PME/POC).

Step 6: **Rank priority areas for biodiversity conservation**

Having selected priority areas for an ecoregion, these will likely cover a significant amount of the ecoregion (24% of the Alps), too vast to start conservation action in all areas at once. Considering the reality of limited resources in the field of biodiversity conservation it is therefore appropriate to try to rank priority areas in terms of urgency or opportunity of conservation action.

The ranking of the priority areas of the Alps was undertaken in two different phases. The first phase took place in 2002 during the Gap workshop, was based on only a preliminary identification of priority areas, and was performed by the experts present at the workshop following a standard template taken from the ecoregion conservation methodology. The second phase took place in 2004 as part of the biodiversity assessment of the priority areas, was based on the final delineation of priority areas and was performed by the consultant Kai Elmauer according to a different set of criteria.

The standard ecoregion conservation methodology recommends ranking priority areas according to their biological importance (including landscape integrity as an indirect measure for biological importance), the level of threat imposed on them, or a combination of the two.

The first ranking of priority areas, undertaken in Gap, proved difficult because the criteria for it had not been discussed and assimilated in advance. In addition, as it was based on a draft map of priority areas, which still included some gaps, it could not be considered fully valid also for the final priority areas (although some good overlap between preliminary and final priority areas exists).

From the methodology point of view, however, it is still interesting to report on the procedure and the results of the first ranking. The experts present in Gap worked on the ranking in groups which were different from those of Steps 2 and 3: no longer according to taxa or habitat types, but according to geographic subregions (the Alps had been divided into five coarse and rather obvious subregions: North-West, South-West, Central, North-East and South-East). Thus, each group included experts on different themes and supposedly had all the needed competencies to do a non-detailed but complete assessment. Experts joined a group depending on their geographic knowledge of the Alps; each group assessed and ranked the priority areas included in that subregion.

Three types of blank datasheets with a proposed work procedure were assigned to the different groups. The proposed ranking criteria were:

- Biological importance. Values 1 (low) to 4 (high) were to be assigned to five features: degree of naturalness, ecological phenomena and processes, habitat diversity (including cultural landscapes), endemics, and species diversity.
- Landscape integrity. This had to be assessed according to three levels: intact, altered/degraded, and heavily altered.
- Threats. Four levels of threat (severe, high, medium or low) for four different types of threats: conversion threats, degradation threats, exploitation threats to wildlife and vegetation, and overall future threat level.

The results of the first ranking exercise are shown in three maps (biological importance, landscape integrity, threats) and should be considered just as a preliminary analysis.

The second ranking of priority areas was performed a couple of years later on the final version of the priority areas, when all the information gaps left had been filled. The ranking undertaken by Kai Elmauer was based on the results of his study Analysis of priority conservation areas in the Alps: biodiversity, threats and opportunities

for conservation (August 2004). For each priority area, the types of existing threats, which were described in his study, were listed and counted, and the priority areas were ranked according to the overall number of threats on them (the higher the number of threats, the more urgent the need to act in the area). The threats considered were:

– depopulation
– urbanization
– holiday houses
– agricultural decline (pastures)
– agricultural intensification (mainly in valleys)
– climate change (erosion, water resources)
– recreation
– tourism (mainly winter tourism, ski areas)
– pollution (water, air)
– mining / gravel extraction from rivers
– damming / hydro power
– wind energy plants
– weak political backing (mainly for protected areas)
– conflicts between protected areas and local people
– poaching
– hunting
– berry and mushroom picking
– fires
– roads / traffic
– forestry
– military training
– invasive species.

Despite the heterogeneity of these threats and their different impact, they were considered all at the same level without any attempt at prioritizing them or assessing their severity.

The analysis of threats was performed both on priority areas individually, and on combinations of them. For example, areas near each other and relatively homogeneous were combined into the same assessment, like for instance:

– areas C (Diois en Drôme) + D (Mont Ventoux en Provence) + E (Vercors), or
– H1 (Sottoceneri-Colline Comasche-Alto Lario) + H2 (Sopraceneri) + I (Alpi Orobie-Grigne), or
– L (Engadina-Stilfser Joch) + M (Brenta-Adamello-Baldo-Alto Garda), or
– N (Dolomiti Bellunesi) + R (Dolomiti d'Ampezzo), or
– O (Karwendel-Isar) + P (Lechtal) + Q (Allgäu) + S (Berchtesgaden).

The rationale behind this proposal of combination of priority areas is that conservation strategies for various species need to be designed and implemented over large areas.

This methodology and the ensuing results are also interesting, as they show a different approach from that used at the Gap workshop. However, some doubts exist regarding the appropriateness of the threats selected by Elmauer and their impact and therefore the results are likely not fully reliable.

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Step 7: **Identify important corridors among priority areas**

To meet some of the goals of biodiversity conservation (maintenance of viable populations of native species within their natural communities, maintenance of ecological and evolutionary processes, conservation of large blocks of natural habitat), connecting priority areas through corridors may become necessary. This is especially important for larger animal species capable of migration and which need corridors for dispersal and to maintain viable metapopulations. Corridors are also very critical for genetic exchange. In addition, large areas are needed to enable habitat and species assemblages to react to large-scale disturbances and long-term variations such as climate change.

Thus, part of the Gap workshop was devoted to identifying corridors among protected areas. Both existing (functioning) and potential (no longer functioning but needed and possible to restore) were considered.

Criteria for the identification of corridors were developed by a group of experts on landscape ecology and corridors present at the Gap workshop. They were preceded by a definition:

Fragmentation is only the separation of habitat patches caused by human intervention. Therefore, high alpine habitat is not fragmented: those divisions of alpine habitat have always occurred.

Specific elements for the identification of corridors were:

– intact rivers and floodplains
– natural, intact mountain passes
– known or "proven" corridors, including those with restoration potential
– areas with a degree of spatial heterogeneity, e.g., stepping stones for many species
– large, intact areas separated by a short distance.

These criteria were integrated with three more after the Gap workshop (during the meeting held in Zurich on 25 March 2003 to finalize the boundaries on priority areas):

– rivers with a certain level of natural dynamics or natural discharge
– altered rivers with restoration potential
– wetlands and mountain passes used by migratory birds.

Additional specific criteria were:

– determine critical maximum distance between intact habitat patches
– as focal species for defining critical distances use species that disperse poorly and are area-sensitive
– avoid placing corridors in areas severed by barriers such as highways, railroads, etc., unless possibility for bridging exists.

The corridors identified during the Gap workshop have to be considered preliminary, given that time was not sufficient to complete the assessment and that the priority areas available on those dates were not final. The identification of corridors would be completed later on, when priority areas were finally identified and a methodology for the identification of corridors was refined. The identification of the main corridors of the Alps (later called connection areas) is thus another activity undertaken in two phases, like the representation analysis. During the second phase, the results of the first phase were taken into consideration.

Step 8: **Conduct a gap analysis for protected areas or other sites considered important**

Several gap analyses were conducted. Most for areas considered important for biodiversity, but some also with other types of land tenure or with infrastructures and the final gap analysis for protected areas is available.

The good overlap of priority areas and protected areas (see for example areas A, B, M, T) can be explained by two factors:

– the biodiversity included in protected areas is generally known better than the biodiversity found outside of parks. This is because research and monitoring in parks are encouraged. The experts who contributed to the identification of important taxon areas obviously had access to this knowledge (or some of them were the producers of that knowledge themselves). As a consequence, the location of important taxon areas - and therefore of priority areas - may be biased in favor of protected areas;
– several protected areas are actually located where habitat is most pristine and biodiversity is at its highest density; additionally, the fact that in some parks human activities are regulated contributes to the maintenance of biodiversity.

On the other hand, the overlap of priority areas and protected areas is not complete, given that not all protected areas are located where biodiversity has its highest density: for example, some are located in areas important only for an individual taxon or few taxa (e.g, wetlands), others are located where the socio-economic conditions allowed for parks, with objectives other than biodiversity conservation. Thus there are areas considered very important for biodiversity (priority areas) which do not include any parks or almost none, like priority areas D (Mont Ventoux en Provence), G (Alpi Pennine – Vallée du Rhône – Oberwallis), J (Bündner Rheintal), K (Alpstein – Churfirsten), V (Koralpe).

An interesting analysis will be the gap analysis with only the protected areas *important for connectivity and biodiversity.* The selection of such protected areas was made by ALPARC in November 2005. This overlay has not been possible so far because the digital data for the protected areas was not available.

The intention of ecoregion conservation is not to set under protection all areas considered priority for biodiversity. However, the gap analysis with protected areas can provide useful information to public administrations and civil society with respect to the role actually played by protected areas for biodiversity conservation.

In the gap analysis for Important Bird Areas, the overlap of IBAs and priority conservation areas is good but not complete: this is due to two factors:

– IBAs and priority areas, both being the expression of a biodiversity vision, are in fact based on two different criteria: importance for birds for the former, importance for the maximum number of taxa for the latter. In part, the fact that IBAs represent areas important for one taxon only (the criterion for identification is the importance for birds) is the reason why - if they are not found in areas important also for other taxa - they have not been included in priority areas.
– in part as the result of the artifact of the coarse boundaries of the priority areas.

The location of IBAs near or between priority areas can however be one criterion to identify connection areas or to warrant the adjustment of priority area boundaries.

In a sense, this gap analysis could be misrepresenting given that the IBAs were one of the layers used to identify the priority areas themselves. However, IBAs are a special category of protected areas and in any case they are a network of sites with acknowledged importance for at least one taxon: birds. They are now entrenched in the European Birds Directive and have therefore become very powerful tools for bird conservation. It thus seems appropriate to verify where IBAs are with respect to priority areas, to know where the conservation of priority areas can benefit from the strength of the European Directives.

The gap analysis for the Natura 2000 and the Emerald networks is also available. Natura 2000 and Emerald sites are areas considered important for biodiversity and they as well are built into the European Directives: hence they benefit from a very strong protection policy. Natura 2000 and Emerald are the expression of yet another biodiversity vision: the protection of sites important for habitat and species threatened in Europe. This criterion is again different from that used for the identification of the priority areas (which are the areas important for the maximum number of taxa), therefore it should not be surprising if the overlap between the two is good but not complete.

The location of Natura 2000 and Emerald sites near of between priority areas can also be one criterion to identify connection areas or to warrant the adjustment of the priority area boundaries.

The gap analysis for Ramsar sites is available.
These sites are sites important for wetlands and are designated under the Ramsar Convention on Wetlands. Sites are designated worldwide and are in the Ramsar List of Wetland of International Importance. Few tens are found in the Alps. They thus represent areas acknowledged as important for a specific habitat type (wetlands). This habitat type in turn supports specific taxa (e.g., migratory birds, water birds).
The designation as a Ramsar site does not imply a protection as strict as that of a Natura 2000 site, nonetheless the recognition of being a wetland of international importance carries some weight. This may or should convey some benefits to the conservation of the priority areas, which contain or are adjacent to Ramsar sites.

The location of Ramsar sites in the Alps near or between priority areas can also be one criterion to identify connection areas or to warrant the adjustment of the priority area boundaries.

The gap analysis for wilderness areas is available and the map of wilderness areas was created by Thomas Kaissl according to specific criteria (Kaissl 2002). Given that such areas are relatively unfragmented and remote, they are also called such (perhaps more appropriately). The overlap of remote areas and priority areas is good but not complete, as with the gap analyses for other layers.
Remote areas, by being such, are mainly at high elevation, often around rocky peaks or covered in glaciers. Because they are relatively undisturbed (unfragmented) and remote, it can be assumed that they ensure the occurrence of ecological and evolutionary processes and that biodiversity within them can take its course without hindrance. As already explained, this is the reason why remote areas adjacent to core areas of maximum taxon overlap were also included in the boundaries of priority areas. Furthermore, wilderness areas often host some specific taxa (e.g. *Tetraonidae*) or habitat types (e.g., glacier forelands) and consequently in certain instances they may play an important role for biodiversity conservation. This is why the overlap of wilderness areas with priority areas is relatively good. Yet, wilderness areas per se are not necessarily all important for biodiversity and do not always qualify to be included in priority areas. In other words, wilderness areas do not always meet the criteria according to which priority areas were identified (overlay of areas important for several taxa). And this is why the overlap of wilderness areas with priority areas is not complete, and the wilderness area layer was not used as a taxon layer.

The gap analysis for developed areas shows developed areas, which in this case are represented by the night-lights seen from satellites, and they can be interpreted as high population densities.
Generally, priority areas are located where developed areas are at their minimum. Two interesting exceptions are: area G (Alpi Pennine-Vallée du Rhône-Oberwallis) and area H1 (Sottoceneri-Colline comasche-Alto Lario), both on the boundary between Italy and Switzerland. Here high biodiversity values coexist with high population densities.

Also several gap analyses were conducted for combination of categories of sites considered important (for example remore areas and developed areas, remote areas and protected areas).

Additional information collected

As described in the preceding pages, several maps and analyses were produced during the eight steps of the methodology. Besides these, other useful information was collected, and in particular:

– considerations on the importance of traditional agriculture for the biodiversity of the Alps
– an agro-biodiversity statement
– a map of the domestic animal breeds of the Alps
– vision and goals for the biodiversity of the Alps
– conservation goals and targets for the entire ecoregion
– conservation goals and target for individual priority areas (by the subregional groups)
– recommendations regarding the Alpine Convention.

They will be briefly described below.
The importance of traditional agriculture in the Alps was stressed on many occasions before, during and after the Gap workshop. This was a recurrent theme, a solicitation coming from different sectors: the scientific community, the social scientists, the civil society, the representatives of the Alpine Convention and of the public administrations. Traditional agriculture generally implies extensive agricultural and farming practices, as opposed to more modern, intensive practices. Traditional agriculture started to shape the landscape of the Alps several centuries ago; the so-called cultural landscapes mostly depend on this practice. About 40% of the Alps biodiversity depends on cultural landscapes and traditional agricultural practices (Grabherr et al., 2000). Additionally, several Natura 2000 species and habitat types – widely recognized by experts and public administrations to be worth protecting - depend on traditional land use practices. Thus, there seemed to be no objection to including traditional agriculture among the important factors to treasure in the Alps for the final goal of biodiversity conservation. This consideration initially seemed counterintuitive to representatives of the North American conservation community, given that their objective generally is to strive for the status of biodiversity which was present before human intervention. However, after discussions and examples they found the Alps emphasis on cultural landscapes rather interesting and appropriate to the regional situation, and considered it worthwhile to present this example to other ecoregions in the world with a comparable regional situation.

An agro-biodiversity statement was developed during the Gap workshop by a group of experts on traditional agriculture and farming. It emphasizes the importance of cultural landscapes as heritage, and of domestic animal and plant breeds as specific adaptations to the local environment. It also proposes different strategies for the use of domestic breeds depending on the conservation value of the various areas. The following statement was also proposed for the Vision and goals developed in Gap: Extensive and ecologically-sound agriculture, whenever possible with locally-adapted breeds and plants, contributes to the protection of a fundamental component of Alpine biodiversity and reinforces also the conservation of the threatened Alpine agro-biodiversity.

The map of the domestic animal breeds of the Alps has already been presented the description of the reference maps available at the workshop in Gap. This map was actually produced in advance and used during the workshop in Gap as reference, especially when developing conservation goals and targets for the ecoregion and for the individual priority areas. However, this map could rightly be considered also as a stand-alone product, and a testimonial to the importance of traditional farming holds for the Alps. The map is a good synthesis of the distribution of the most important or representative domestic animal breeds in the Alps.


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A vision and goals for the biodiversity of the Alps were discussed during the workshop in Gap, where all participants were requested to submit their opinions. The following is a statement which synthesizes the input received:

Biodiversity represents an extraordinary value for the Alpine region and is strictly linked to the quality of human life.

The typical features of Alpine biodiversity are ensured by the existence of efficient and long-lasting biocenoses.

Alpine diversity results from a mosaic of the natural and the cultural landscape. Its survival is ensured by components as diverse as: sustainable management practices, pristine areas, a network of protected areas, ecological processes, the extensive use of agricultural land, and the presence of ecological corridors.

The human inhabitants of the Alpine region will ensure the conservation of the biological variety of the Alps by means of their ecologically-compatible behaviour.

Conservation goals and targets for the entire ecoregion were developed during the third day of the Gap workshop.

Conservation goals and target for individual priority areas were also developed during the third day of the workshop by the subregional groups.

Finally, recommendations regarding the Alpine Convention were developed by a group of experts and of observers at the Alpine Convention itself. First of all they highlighted the fact that the Convention, and especially the Nature Protection and Landscape Conservation Protocol, is an existing framework for:

– landscape planning and spatial planning, both at the local and at the pan-Alpine scale
– protected areas
– ecological linkages / corridors
– contrast to alien and invasive species
– international collaboration.

The solutions they advocated for biodiversity conservation within the framework of the Alpine Convention were:

– As part of the development and the implementation of the Convention, the Convention itself should somehow integrate more recent frameworks such as Natura 2000 and the Convention on Biological Diversity
– Ad hoc working groups should be established for concrete implementation
– Functioning structures should be established within the Alpine Convention (e.g., a Permanent Secretariat, a system for observation and information-SOIA, a budget, an integration of the EU)
– Corridors between mountain regions (Alps and other surrounding regions) should be identified and made functioning
– The EU Common Agricultural Policy should be reformed to reflect the needs of biodiversity conservation
– The transportation policy should be revised so that economic growth should not come at the expenses of an increase in transport (both of goods and for leisure), and by internalizing external costs with subsequent use of the funds for prevention, compensation and restoration of environmental damage
– The tourism policy should undergo a paradigm shift: no new winter sport development should be undertaken in intact landscapes and overall tourist activities should become more sustainable.

Incidentally, since 2002 when these recommendations were issued, a few things have changed:
– Natura 2000 was integrated into the ALPARC/Alpine Convention study of corridors among protected areas in the Alps (2004).
– An attempt was made to involve the Permanent Secretariat of the Alpine Convention into the 1st meeting of the Ad Hoc Working Group on the Programme of Work on Protected Areas of the CBD, which took place in Montecatini (Italy) in June 2005. Unfortunately, however, the Permanent Secretariat was unable to participate.
– Ad Hoc working groups for concrete implementation have been created; one of them is that of ALPARC on protected areas and their corridors.
– The Permanent Secretariat of the Alpine Convention now exist, with headquarters in Innsbruck (Austria) and a technical secretariat in Bolzano (Italy).
– Corridors between the Alps and other mountain regions have been identified in 2005-2006 as part of the initiative of the Consortium on connection areas.
– The Common Agricultural Policy has been reformed. Whether the new policy will have a positive impact on biodiversity still has to be seen.

Results on priority conservation areas

The results obtained on priority conservation areas are described above and they can succinctly be summarized as follows.

Map results:
– important areas for major taxon groups: vegetation/flora, large carnivores, large herbivores, medium and small mammals (these three layers were combined into one map only), birds (including a consolidated map with all the IBAs for the Alps), herpetofauna, terrestrial invertebrates (insects)
– important freshwater habitat
– priority areas on which to focus conservation work
– preliminary wildlife/vegetation corridors among priority areas
– level of threat of the different priority areas
– level of ecological integrity of the different priority areas
– level of biological importance of the different priority areas
– gap analysis of priority areas with protected areas
– gap analysis of priority areas with Natura 2000 and Emerald sites


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– gap analysis of priority areas with Important Birds Areas
– gap analysis of priority areas with Ramsar sites
– gap analysis of priority areas with remote areas
– gap analysis of priority areas with developed areas
– distribution of urbanization hotspots
– distribution of domestic animal breeds
– representation analysis by biogeographic subdivision
– representation analysis by natural potential vegetation

Non-map results:
– a vision statement
– criteria for corridor identification
– principles for an agro-biodiversity strategy within priority areas
– a detailed analysis of biodiversity, threats and opportunities for conservation of priority areas
– a detailed socio-economic analysis of priority areas
– a network of scientists prepared to think at the scale of the entire Alps
– a network of public administrations and other parties willing to implement the biodiversity vision on the ground.

Other important non-tangible results, or conclusions worth highlighting, follow.

1) The boundaries of the priority areas are an approximation: they indicate general locations where it will be worthwhile to conduct a more detailed analysis.
2) As shown before, the boundaries of the priority conservation areas include developed areas. This is not a contradiction because priority areas are not what is left to protect, but what is important for biodiversity and therefore deserves special attention. The needs of biodiversity can be meet either through conservation, or through restoration and appropriate management.
3) To integrate the point above, it is relevant to note how about 85% of the Alps are important for at least one taxon or habitat type. It is therefore important to consider the conservation of the Alps as a whole and not only of the priority areas.
4) As mentioned below, the gap analysis with protected areas can provide useful information to public administrations and civil society with respect to the role actually played by protected areas for biodiversity conservation. However, the intention of ecoregion conservation is not to set under protection all areas considered as a priority for biodiversity: priority areas should be recognized for the species composition, but they do not equal protected areas. The real challenge will be to envisage appropriate land tenure forms and management measures to ensure the coexistence of biodiversity with human activities: conservation can occur within a human landscape as well. This leads to the important formulation that ecoregion conservation is not just about conservation, but also about sustainable development.
5) Some think that, in certain cases, priority areas should be combined to form larger land units. Combination of priority areas would be especially appropriate when the areas are homogeneous and when they host – or potentially host – wide-roaming species. However, this may result in rather complex conservation or management work, given the vast areas on which these should take place. To this regard, the point was made that "large-scale soft management is better than strict protection on small-scale areas". In other words: strict protection may be helpful, yet difficult to enforce and also perhaps not always a rigorous requirement for the needs of the biodiversity present. On the contrary, appropriate management (*soft* protection as opposed to *strict* protection) may be the best response to the needs of the biodiversity in the area and would therefore be the preferred option, one which is also more manageable on a large surface.
6) There is a synergy – and not a competition – between the map of priority areas and the map of sites of the Natura 2000 and the Emerald networks. The two complement each other.

Overall, the process leading to the identification of the priority areas was a success. Participants in the Gap workshop, the largest of the events organized for the development of the biodiversity vision for the Alps, were overwhelmingly. The few comments which mentioned negative aspects were used to guide subsequent efforts, to improve the results and to learn lessons which will be helpful in the future.

Methodology for the identification of the connection areas of the Alps

Summary: brief description of the process

As already mentioned, a first attempt to identify the main connection areas of the Alps (then called *corridors*) had already been made in 2002 during the work on priority areas. That attempt, however, did not come to final conclusions given that priority areas had not yet been finalized, criteria for corridors had to be further discussed and time for this task at the Gap workshop had been limited. Therefore, a new and more substantial attempt was made in 2005-2006.

A detailed report (April 2006) solely on the connection areas of the Alps is also available for further information: *Identification of the main potential connection areas of the Alps. Technical report including: the workshop in Buchs-CH (19-20 September 2005), the expert input received prior to it, the suggestions gathered at the workshop in Berchtesgaden-D (7-8 November 2005), and the Consortium's conclusions.* In addition, a summary of the methodology and of preliminary results on connection areas is also available.

The work on connection areas was framed and conducted with the same partners which had cooperated for the identification of the priority areas and which together constitute the Consortium (WWF, CIPRA, ISCAR and ALPARC). Technical partners for this phase were VINCA in Vienna, AT for the GIS work and Alterra Institute in Wageningen, NL for guidance on ecological network theory and practice.

The objective of the Consortium was therefore to complete the biodiversity vision for the Alps by identifying the main potential connection areas, which would integrate the priority areas already identified. The main potential connection areas thus identified would then be proposed to the Alpine Convention as the contribution of the NGOs to the implementation of the Nature Protection Protocol of the Alpine Convention itself.

By *main potential connection areas* of the Alps we mean the *areas of Alpine importance or pan-Alpine scale where ecological connectivity exists, is potential or is needed.*

The expressions "main", "pan-Alpine scale" and "Alpine importance" indicate that the connection areas identified have an important role for the ecological integrity of the Alps as a whole. The terms do not refer to their geographic extension nor do they mean that connection areas have to cross the entire Alps from west to east or north to south. It is their importance level which is the point: an area of Alpine importance is an area which plays (or could/should play) an important function for the Alps, and not simply for an individual site, a park, a community, a province (Italy), a région (France), a canton (Switzerland), a Land (German-speaking countries) or a country. Nor is it necessarily a connection area that goes across national boundaries.

The word "potential" indicates that the status of connectivity can range from fully functioning (connectivity exists; the area is actively used as an ecological corridor) to non-functioning (connectivity currently does not exist or the detailed analysis proves that it is not needed). The actual status of connectivity within each connection area will have to be determined through a more precise, subsequent analysis. Functioning connection areas simply need to be kept such; non-functioning connection areas may either be returned to activity with appropriate restoration or remediation measures.

Keeping in mind the definitions above, the main potential connection areas of the Alps may be called more simply "connection areas".
The point of identifying the main potential connection areas of the Alps is to define where a more precise analysis is needed and therefore where action is most required and of what kind.

The identification of the main potential connection areas of the Alps for the completion of the biodiversity vision was coordinated with another initiative related to corridors in the Alps: that of ALPARC aimed at identifying connections among Alpine protected areas. ALPARC received in 2004 by the Alpine Convention the mandate to develop a model for the establishment of connections among protected areas by means of precise corridors, special measures or other ad hoc procedures. This project was a way to contribute to the implementation of the Nature Protection Protocol of the Alpine Convention. ALPARC identified eight areas (mostly transnational) in which to test the model (these areas overlap generously with some priority areas identified during the biodiversity vision).

For these areas more detailed analyses were conducted (in a sort of "zooming in") and concrete proposals were developed for the implementation of specific measures and of links among protected areas. The results were published in 2005 in *Alpine Signals #3*, and a few pilot areas should begin in 2006 to concretely implement the results of the model.

To avoid confusion, it was agreed that corridors identified at a more precise scale (e.g., according to the ALPARC's approach) would be mentioned as "corridors" *sensu strictu*; while corridors identified according to the biodiversity vision principles, at a coarse, non-detailed scale and only approximately located (e.g., according to the Consortium's approach) would be mentioned as "main potential connection areas" (connection areas) or "macro-corridors".

The model proposed by ALPARC for the identification of corridors at a more detailed scale is a good tool to move from (overall) vision to (local) action. Furthermore, it prepares the ground for when the biodiversity vision will be completed with the connection areas (its approach can be used to zoom into the connection areas).

The connection areas will complete the biodiversity vision. The priority conservation areas and the protected areas as such are not an ecological network; rather, more similar to core areas. Furthermore, some priority areas and some protected areas are considered to be too small to effectively conserve the biodiversity they were created to protect. Through the identification of the connection areas we would "provide more space" to the priority areas that are too small and which need to be larger for the needs of the biodiversity they were deemed important for; we would capture the ecological and evolutionary processes otherwise very difficult to map and provide for; and we would ensure that the Alps will always be connected to the regions adjacent to them (the Alps as a whole – like the individual priority areas – should not be seen as an island either; rather, they should be seen and managed as a key part strictly interlinked to the rest of the continent).

In the connection areas that have been identified, the quality of connectivity and the location of the corridors will be further analysed and a concrete, detailed proposal for types of land tenure and land use that ensure the connectivity function will be made.

Some connection areas of the Alps were identified in 2005-2006 by asking experts to identify them according to their own knowledge and experience (expert approach) and based on certain given criteria, through a workshop, which was held 19-20 September in Buchs-CH, and through more consultations with experts after the workshop.

Data collection, scope and scale issues, GIS issues

As for priority areas, the geographic scope of data collection, analysis and mapping was the entire Alpine range according to the boundaries defined by the Alpine Convention. Besides this area, however, the regions adjacent to the Alps were also considered as a necessary geographic addition for the identification of connection areas between the Alps and their surroundings and thus for the clarification of the functional role of the Alps within the wider continent.

Given that connection areas were to be integrated with priority areas to complete the biodiversity vision, and that priority areas had been identified at a 1:500 000 scale, the scale for the identification of connection areas was confirmed at 1:500 000. This coarse scale is also recommended by the biodiversity vision process, provides an overall context and allows for further and more detailed analyses in a subsequent phase.

The used projection remained Lambert Equal Area Azimuthal with parameters 9 and 48.

Reference maps and data sources

At the workshop in Buchs (19-20 September 2005) the following maps were available as reference material, which were produced by the GIS expert prior to the workshop mainly in A0 format:

– A copy of the actual individual input provided by the experts and a table that shortly described the experts basis for their input
– A0 map showing the synthesis of the inputs received from experts prior to the workshop. As many experts provided existing maps instead of using the base map provided by the organizers, this information had to be transposed or translated to one map.

Other reference maps were produced by the GIS expert during the workshop itself, available in A3 format:

1) Map of priority conservation areas, protected areas and other areas acknowledged as important for biodiversity in the Alps (IBAs, Ramsar sites, remote areas, sites important for bird migrations)
2) Map of priority conservation areas and other areas acknowledged as important for biodiversity in the Alps (IBAs, Ramsar sites, remote areas and sites important for bird migrations), but no protected areas
3) Map of priority conservation areas, areas recognized as important for biodiversity (IBAs, Ramsar sites, remote areas, sites important for bird migrations) and built-up areas in the Alps
4) Map of Important Bird Areas (IBAs) and Ramsar sites in the Alps
5) Map of elevation (Fig. 2) and sites important for bird migrations in the Alps
6) Map of priority conservation areas and protected areas in the Alps (Fig. 18) and related land cover statistics
7) Map of priority conservation areas and remote areas in the Alps
8) Map of priority conservation areas in the Alps (Fig. 17) and synthesis of expert inputs
9) Map of land cover in the Alps (Fig. 6).

Existing maps, which were also available at the workshop as reference material:
– Map and report of the Swiss REN
– Map of the Italian REN (A3)
– Map of ecological corridors in Germany (Lebensraumkorridore für Mensch und Natur
– Indicative map of a German habitat corridor network, May 2004)
– Map with the corridors identified along the border of Germany (Vermessungsverwaltung del Länder und BKG 2004)
– A poster map of all protected areas in the Alps, with their names and categories (by ALPARC)
– A map of Slovenian protected areas
– A map of Italian protected areas
– Topographic maps of France and Italy, for orientation.

The data sets used for the creation of the maps on barriers, elevation, land cover, priority areas and protected areas are described in Table 5.

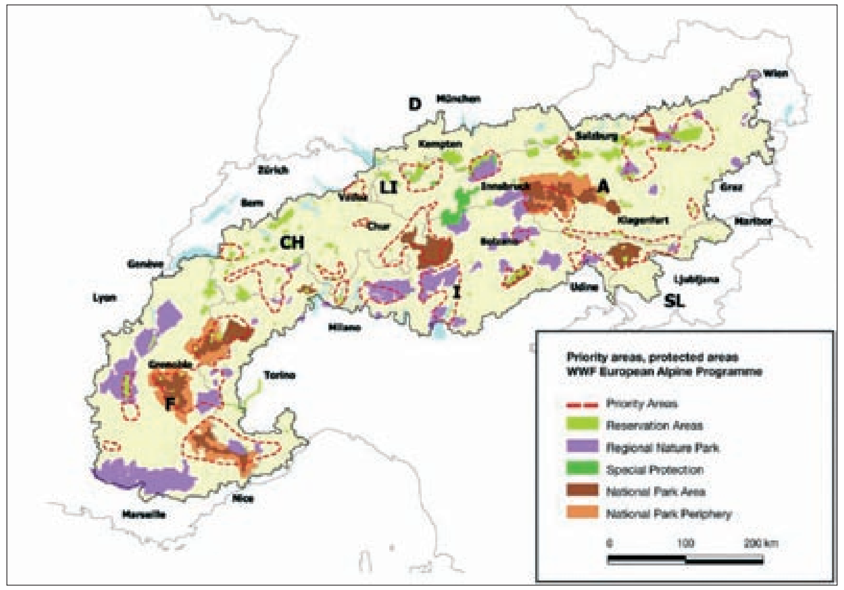

Fig. 18: Map showing priority conservation areas and protected areas in the Alps

Table 5. Description of the data sets used to create the maps on barriers, elevation, land cover, priority areas and protected areas for the Buchs workshop.

Data set	Sources	Description
Barriers	Corine Landcover, Teleatlas, Digital Chart of the World	Map showing built-up areas, motorways, major roads and railways
Elevation (Fig. 2)	GLOBE (Global Land One-km Base Elevation)	Digital Elevation Model raster map with a spatial resolution of 1km.
Landcover (Fig. 6)	Liechtenstein: Pelcom Switzerland: Switzerland land cover reclassified to CORINE level 2, European Topic Center on Land Cover ETC/LC – EEA Other: Corine Landcover	The landcover data set was assembled from different sources. Because of the different classifications of the input data, it was necessary to build a coarser, consistent legend. The result was a raster map with a spatial resolution of 250m showing 8 classes: - Urban, industrial, mining, transport - Agriculture - Forest - Natural grassland, moors & heathland, shrubs - Bare rocks, glaciers, perpetual snow - Inland wetlands - Coastal wetlands - Inland waters
Priority Conservation Areas and Protected Areas (Fig. 18)	WWF, The Alpine Network of Protected Areas	Polygons showing the priority conservation areas, nationals parks, regional nature parks, reservation areas and other areas under special protection. All protected areas come from the ALPARC data set from 2002.

Methodology and rationale

Objective of the initiative

The objective of the initiative was to identify at the macro-level (Alpine scale) the main existing and potential connection areas of Alpine importance both among the priority conservation areas and protected areas and between the Alps and the adjacent regions, mainly based on an expert approach.

Other initiatives to consider and synergies

The identification of connection areas in the Alps had to keep into consideration other initiatives at the national, European or global level which are related to corridors (in addition to the initiative by ALPARC and the Alpine Convention, already described):

- Development of national ecological networks in the Alpine region (Switzerland, France, Italy, Germany/ Bavaria)
- Development of a Pan-European Ecological Network (PEEN) since 1995 under the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) (the map for the PEEN for Central and Eastern Europe is complete, and that for South-Eastern Europe is drafted. No map for Western Europe exists yet, but a contact was established with the PEEN council to make sure a synergy is in place between this third PEEN map and the Consortium initiative on the connection areas of the Alps)
- Development of the Natura 2000 network and specifically Article 10 of the Habitats Directive that underlines the need for development of corridors
- The discussion that is taking place in the framework of the Convention on Biological Diversity regarding the need to enhance connectivity among protected areas or other areas important for biodiversity.

In fact, the intention was to capitalize on what already exists and to maximise synergies. If initiatives exist to identify corridors at national or local scale, their results should be considered in light of the objectives of this pan-Alpine initiative. This is the case for the national ecological networks already identified by some Alpine countries (e.g., Italy and Switzerland), or the regional ecological networks identified for some portions of other countries (e.g., Bavaria, southern France), and it relates to the policy relevance principle described which will be described below. It is certainly not easy to integrate the conclusions of such national/regional ecological networks, because they are based on different approaches, data and scales; in addition, not all corridors identified at a more detailed scale (i.e., of national or regional importance) may be relevant for the Alps as a whole (i.e., are of Alpine importance). However, these ecological networks are the result of thorough scientific thinking and are often entrenched in the national policies, therefore they have some power at least at national level and deserve to be looked at with attention. Their contribution to the identification of connection areas in the Alps has to be evaluated on a case-by-case basis.

Assumptions and decisions

Thanks to suggestions provided by experts before and after the Buchs workshop, the following assumptions and decisions were made for the identification of connection areas in the Alps:

- Plants. Most botanists consulted thought that at the coarse scale of 1:500 000 it would not be appropriate to identify connection areas based on individual plant species. The colonization of new environments by plants is a very slow process and could be taken into consideration when working at a more detailed scale. Of course this is not to say that habitat or vegetation types should not be used for the identification of connection areas.
- Invasive plants. Experts thought that connection areas should not be identified based on the risk of plant invasions either. In addition, invasive plant species do not seem to be a major problem in the Alps at this point, however management capacity should be in place to respond to the spreading of new species, should this be detected (as suggested by specific guidelines developed by the Swiss government to try to contrast this risk). In general, invasive plants tend not to spread along "natural" corridors, but rather along man-made or "disturbed" corridors such as intensive agriculture areas, roads, highways and railways (an exception could be the – albeit limited – invasion of *Reynoutria japonica* on the riparian areas of the natural course of the Tagliamento River). Invasive species would take a long time to colonize new areas along natural corridors (which can be assumed to have the least possible anthropogenic disturbance and the most natural areas). Furthermore, invasions of alien plants tend to originate in the lowlands and do not adapt well to mountain conditions.
- Invasive animal species and river connection areas. Some connection areas, especially aquatic corridors in the southern Alps, may facilitate the dispersion of invasive, alien species and in particular the upstream colonization by such species from the Po River Valley (lowland) to the mountainous Alpine region. This risk should definitely be taken into consideration, especially when designing management actions for the connection areas identified. In the case of the river corridors, the *nodes* (points where smaller rivers join a larger or lowland one) are especially critical.
- Climate change. It surely is an important factor that needs to be considered when discussing connection areas (it also affects the hydrological system). However, given the rapidly evolving science and the many uncertainties around this topic, for the time being this aspect was not taken into account. It was suggested to focus on the short-term needs and at a later stage take into account the long term requirements in the light of climate change.
- Plants and climate change. Some experts thought that – given that plants cannot be protected against climate change and global warming – then we might overlook plants at this scale. Global warming may actually increase diversity at the level of plant species. It is possible to predict which types of vegetation will stand warmer conditions and which types will be replaced, therefore it is *vegetation* and not *plants* we should focus on at this point, as explained above. A suggestion, which was made, was to consider the effects of climate change on the distribution of individual plant species for the *prioritization* and *management* of the areas identified, rather than for their *identification.*
- Invertebrates. Experts in this field thought that most invertebrates would not operate at this scale (1:500 000). In addition, invertebrates use a wide range of different dispersal mechanisms, making identification of possible connection areas difficult. However, for flying invertebrates the same areas used by migratory birds could apply: more attention should therefore be paid to bird migration areas and routes. In the future it could be interesting to investigate whether groups of colonizing invertebrates (e.g., *Carabidae, Ortoptera*) could be appropriate focal taxa for the identification of corridors.
- Amphibians. Also experts on this taxon thought that the scale of analysis for the potential connection areas (1:500 000) would not apply to amphibians. This taxon may be looked at with more attention when working at a more detailed scale.
- Ecological connectivity between the Alps and the surrounding lowlands. During the identification of the river connection areas in the Southern Alps, it

was stressed that the biopermeability of the two regions (Alps and lowlands) is very different. In the Alps the biopermeability is still high and the issue is *conservation* (in some cases also *mitigation* and *compensation* of existing barrier effects); in the lowlands (in this case the Po River Valley) the biopermeability is heavily degraded and the issue is rather *management* and *restoration*. The implications of this aspect for ecological connectivity should be and further investigated.

As a result of these assumptions and considerations, it was decided to identify the connection areas of the Alps focussing mainly on the ecological needs of certain taxa only (mammals and birds), and on the distribution and quality of habitat and vegetation types (terrestrial and aquatic), landscape structure and other as described further on.

Principles and approaches for the identification of connection areas

During the first phase of this initiative also three different principles were defined according to which connection areas could be identified, and which could be integrated into the experts' approach: 1. ecological need, 2. feasibility and opportunity, 3. policy relevance and political acceptance (they are not necessarily independent of each other).

1) Ecological need for connection areas among the priority areas and the protected areas, and between the Alps and the adjacent regions. This principle is based on the assumption that connection areas should be identified based on the ecological need to connect priority areas for species, habitats and other ecological processes. Prior to the workshop experts were asked to suggest, based on ecological criteria, where the best options were for connections.
   a. Expert knowledge from the field, either from the experts themselves or from existing studies (historical or actual dispersal and migration routes of large carnivores or herbivores, need to connect populations of large carnivores and herbivores in order to ensure population viability, interviews with game wardens etc)
   b. Knowledge based on modelling studies (mostly habitat suitability for large carnivores, herbivores)

Sometimes the suggestions received were based on a combined approach of modelling and expert interpretation.

2) Feasibility/opportunity for developing connection areas. This principle is based on the assumption that connection areas should be identified based on current land use tenure and/or intensity (occurrence of natural habitats, population density and occurrence of large cities, occurrence of barriers such as roads, railroads etc.). It identifies where the best options remain among the priority areas for connection areas given the current land use and tenure, as well as the existing pressures. This principle is developed and described in detail by the Alpine Convention, and is the basis for ALPARC's identification of more precise corridors among protected areas.

3) Policy relevance and/or political acceptance for connection areas. This principle is based on the assumption that connection areas should be parts of identified national or regional ecological networks (REN), which are now official governmental policies of the national or regional administrations. Switzerland[7] and Bavaria have developed national or regional ecological networks (REN), which are now official governmental policies of the national or regional administrations. Furthermore in France[8] and Italy[9] scientific studies on ecological networks exist. Also, four of the countries surrounding the Alps - namely Slovakia[10], Czech Republic[11], Hungary[12] and Croatia[13] - have developed national or regional networks. According to some experts who sent in material in advance to the workshop as well as discussion in the workshop, this could be one of the bases for identifying macro connections in the Alps. The national and regional networks are often founded on scientific studies regarding occurrence of species, migration and dispersal routes (modelling, expert knowledge) and in some cases on political consultation. However, by definition, national networks are identified or designed on a national scale, and they do not have the wider Alpine region as their context.

It should be stressed that the three principles outlined above are not independent of each other. For instance, if land use over a large surface is very intensive and most large vertebrates have disappeared due to the lack of suitable habitats, the ecological need to develop connection areas for these species is limited. However if areas are still in pristine conditions the need to create or possibly even identify connection areas is absent. (This is not to say that a connection area no longer functioning but formerly connecting habitats should not be restored.)

Of these three principles, it was decided to identify the connection areas according to the ecological need principle and based on a combination of the species approach and the habitat approach. It was further decided to evaluate the results obtained from the ecological need principle using the feasibility/opportunity principle. This method will help to answer the question "which of the connection areas that have been identified according to the ecological need principle are more feasible than others according to the situation on the ground and at administrative level?" The connection areas identified with this method would then be validated through the input already received and which will be received in the future during consultation time.

By a basic definition, the species approach bases the identification of connection areas on the needs of species and communities (need for migrations, for dispersal, for genetic exchange, etc.); the habitat approach bases the identification of connection areas on the distribution, composition, structure, size, condition and context of the habitat or landscape types; the habitat approach is linked to the concept of ecological function and continuum (given the data available at the workshop and the fact that no detailed habitat information was available, land cover was used instead). The reasons provided for adopting not only the species approach but also the habitat approach were:

1) The priority areas are identified based on the maximum overlap of areas important for different taxa. As a result most of the areas do not correspond with the actual distribution of large carnivores or large herbivores. Therefore identifying connection areas based solely on an assessment of whether the priority areas and protected areas are large enough for the maintenance of viable species populations was considered by some experts difficult or not significant.
2) Many large carnivore species are very mobile and not restricted to specific habitat types: using them as target species to identify connection areas might not work. Furthermore, for most large carnivores, recognized barriers may not be such. Also from a political point of view - given the objections and sensitivities around large carnivores - using them might not be wise.
3) On a macro-level it might be wiser to look at altitude, existing habitats and resistance of the landscape in general instead of specific species requirements, which might be more suitable on the micro-level.

The work procedure used in the workshop allowed to relate the different principles to each other and to indicate synergies and discrepancies.

Internal and external connection areas

Through preparatory consultations with experts, the first workshop in Buchs in September 2005 and further subsequent consultations, two draft maps were produced: one for external connection areas (Fig. 19, connecting the Alps to adjacent regions) and one for internal connection areas (Fig. 20,. connecting priority conservation areas to each other, where appropriate).

Both maps are preliminary, need further peer-review and by no means should they be considered final. However, the map of external corridors is more reliable than that of internal corridors. Also, the scientific methodology with which the maps were produced has to be finalized.

[7] BUWAL 2004 Nationales ökologisches Netzwerk REN. Schlussbericht. Schriftenreihe Umwelt 373
[8] Espaces naturels et ruraux, 2002. DATAR. Ministère de l'Agriculture et de la Pêche & Ministère de l'Aménagement du Territoire et de l'Environnement.
[9] http://www.gisbau.uniroma1.it/ren.php
[10] IUCN 1996. National ecological network Slovakia. P. Sabo (ed). IUCN, Bratislava.
[11] Buček, A., J. Lacina & I. Michal, 1996. An ecological network in the Czech Republic. Veronica. 11th special issue.
[12] IUCN 1995b, National Ecological Network- proposal for environmental and nature-friendly regional planning, IUCN, Gland, Svájc és Budapest, Magyarország.
[13] http://www.cro-nen.hr/

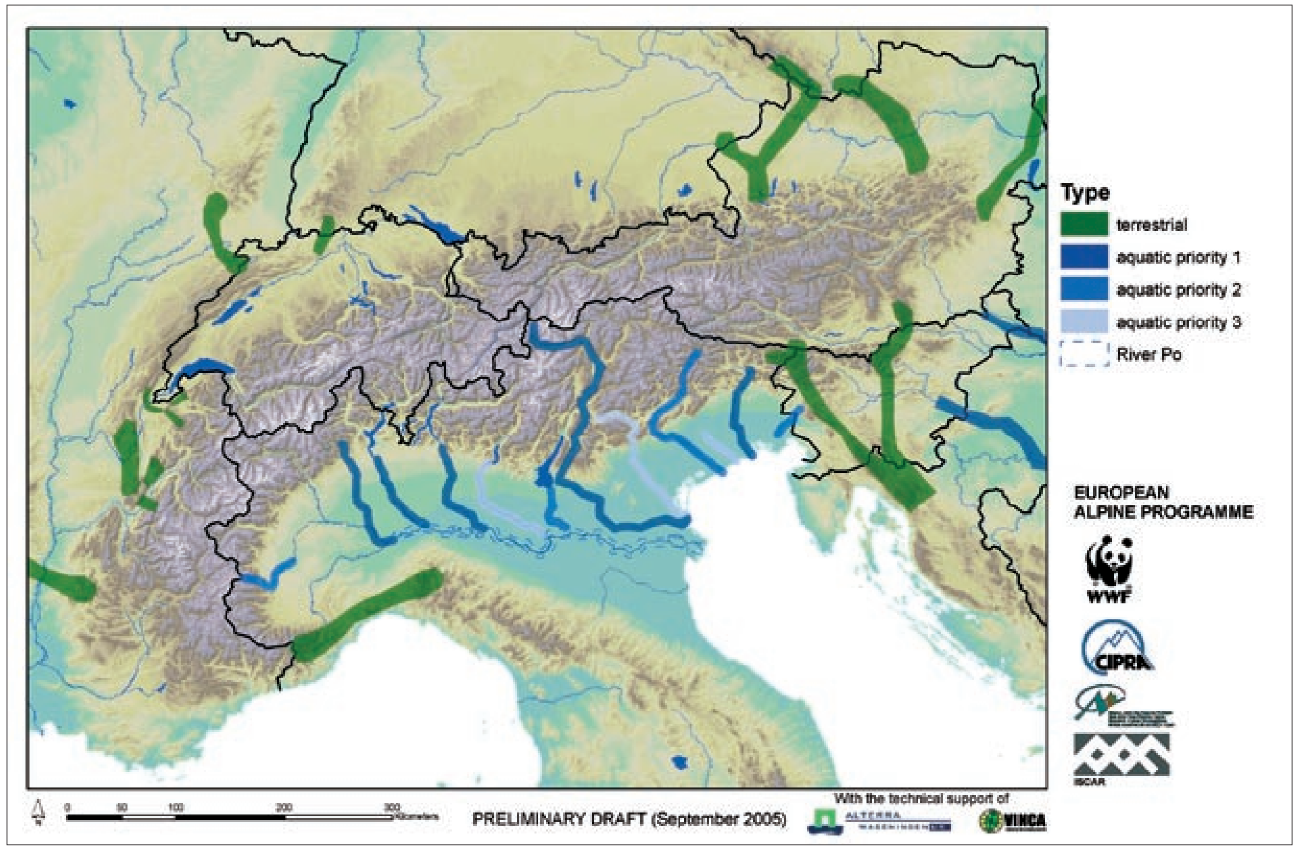

Fig. 19: The main potential connection areas connecting the Alps to adjacent regions (external macro-corridors). The map is a preliminary draft and cannot be considered final. It distinguishes the main potential connection areas in terrestrial (green) and aquatic (blue). River macro-corridors have been identified only for the southern Alps and they were temporarily ranked according to three levels of priority: they should also be identified for the northern Alps. 1: Drava River. 2: Sava River. 3: Dinaric Alps East. 4: Dinaric Alps West. 5: Alps-Carpathians. 6: Alps-Bohemian Massif. 7: Kobernausserwald Corridor. 8: Jura-Black Forest. 9: Jura-Vosges. 10: Alps-Salève-Jura. 11: Alps-Chartreuse-Jura. 12: Alps-Massif Central. 13: Alps-Apennines.

External connection areas

A few connection areas between the Alps and the adjacent regions were identified, before, during or after the Buchs workshop. They are called *external* connection areas because they extend beyond the boundaries of the Alpine region per se. They connect the Alps with:

– South-Eastern Europe (the Drava River, the Sava River)
– the Dinaric Alps towards Slovenia and Croatia
– the Carpathians (through Austria and Slovakia)
– the Bohemian Massif (in Austria, the Czech Republic and Germany)
– the Jura Mountains (in Switzerland and France) and from here to the Black Forest (Germany) and the Vosges (France)
– the Massif Central (France)
– the Apennines (Italy)
– the Po River Valley and the Adriatic Sea (Italy).

The belts/ribbons on Fig. 19 indicate the connection areas between the Alps and the adjacent regions (external macro-corridors).

This draft map definitely enjoys more consensus than the map of internal macro-corridors (described below under 5.6): all macro-corridors presented will most likely withstand further peer-review, but new ones are needed to complete the picture (e.g., from the Alps northbound).

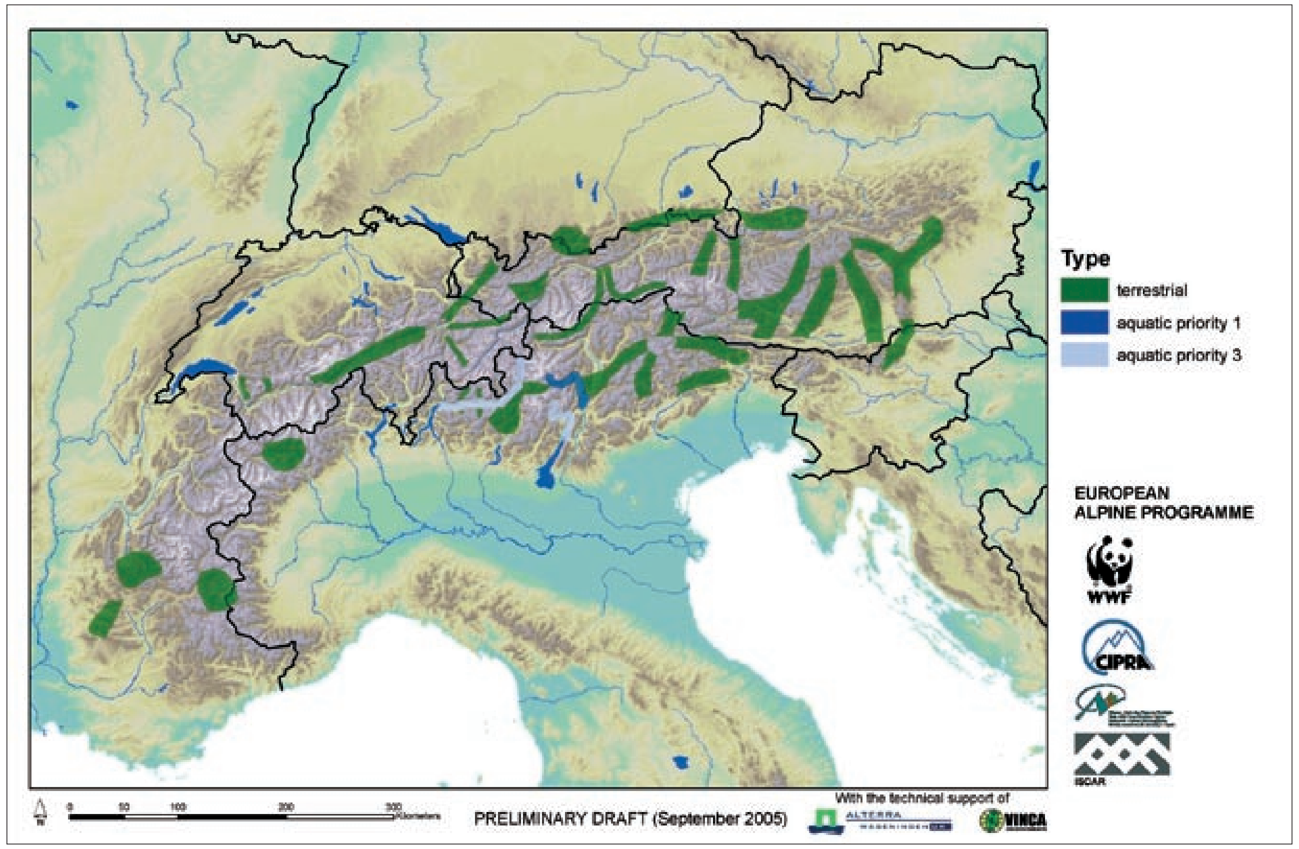

Fig. 20: The main potential connection areas within the Alps, connecting priority areas to each other, when necessary (internal macro-corridors). The map is a preliminary draft and cannot be considered final. It distinguishes the connection areas in terrestrial (green) and aquatic (blue).

Internal connection areas

For the identification of internal connection areas, at the Buchs workshop the experts present were divided in two groups – one for the Western Alps and one for the Eastern Alps[14]. For this reason, most internal connection areas identified in the Western Alps have "W" in their code, and those identified in the eastern Alps have "E". Macro-corridors without "W" or "E" were not identified at the workshop but before or after it.

Fig. 20 outlines the main potential connection areas identified in a preliminary way within the Alps (internal macro-corridors).

Overall the experts in Buchs were able to use the flowchart but they did experience some difficulties and made some remarks on the overall approach.

[14] Experts for the Eastern Alps: Toni Nikolic, Michael Proschek. Experts for the Western Alps: Hervé Cortot, Christoph Küffer, Fridolin Zimmermann.

Other analyses

Several other analyses were conducted on, or related to, the connection areas of the Alps:

10. overlay with other layers of information
11. comparison with maps of the Pan-European Ecological Network
12. comparison with the corridors identified in 2002
13. protected areas important for biodiversity and connectivity
14. suggestions for extension of priority area boundaries
15. comparison with other corridors suggested.

These will be briefly described below.

1. Overlay with other layers of information

As an exercise, the main "internal" and "external" potential connection areas identified in a preliminary way at the workshop were integrated into one map and overlaid onto other levels of information (priority conservation areas, protected areas, areas under other types of protection or otherwise recognized as important for biodiversity, expert input, remote areas). The following maps show the results of these other analyses.

2. Comparison with maps of the Pan-European Ecological Network

In the framework of the Pan-European Biological and Landscape Diversity Strategy two regional maps were produced that identify the Pan-European Ecological Network (PEEN) for Central & Eastern Europe and for South-Eastern Europe (that for Western Europe has not yet been produced). A brief analysis was undertaken to verify whether the connection areas identified for the Alps correspond with these maps. In particular, the objective of the analysis was to assess whether the external connection areas identified for the Alps were seamlessly connected to the ecological network of the adjacent Central and South-Eastern Europe, or in any case whether internal and external connection areas for the Alps had other types of relationships with the portions of PEEN already identified. (Given that the PEEN maps currently available are only those for Central & Eastern Europe and for South-Eastern Europe, this analysis included only the eastern and southeastern portions of the Alps.)

The results of this brief analysis were rather interesting and encouraging. For Central & Eastern Europe:

1) Connection area 5 of the Alps (external macro-corridor between the Alps and the Carpathians) was also identified on the indicative map of the Pan-European Ecological Network for Central & Eastern Europe.
2) External connection areas 6 and 7 of the Alps (respectively Kalbhalpen Corridor - or connection with the Bohemian Massif - and Kobernausserwald Corridor) were not identified on the PEEN map, although the Bohemian Massif in the border region was indeed identified as a core area due to its current international protection status as well as its size. According to the methodology followed in the PEEN project, this area should be connected to a larger forested area in the vicinity.

For South-Eastern Europe (no figure included as per ECNC's request given that the map is still a draft):

3) For South-Eastern Europe the map is not complete yet, but only a draft version is available. On this draft version, the area covered by connection area 4 of the Alps (external macro-corridor Dinaric Alps West) is indicated as one continuous core area that connects the Julian Alps with the Dinaric Alps (the area is presently not severely fragmented). This coincides with the assessment made during the Buchs workshop according to which this area is an important connection area between the Alps and the Dinaric Arc. The difference is that, as a result of the methodology used in the PEEN project, PEEN considers this same area as one core area and not as two separate areas with a corridor in between.
4) Connection area 3 of the Alps (external macro-corridor Dinaric Alps East) was also identified as a corridor in the draft version of the PEEN map for South-Eastern Europe.

3. Comparison with the corridors identified in 2002

During the workshop, which was held in 2002 in Gap, France, when the identification of priority areas started, a preliminary identification of some corridors among priority areas had also been undertaken.

These corridors cannot but be considered preliminary because they were established among priority areas which were then not yet final (and which have since undergone changes in boundaries). However, it was interesting to see whether there were any correspondence between these corridors and the connection areas identified in 2005-2006.

4. Protected areas important for biodiversity and connectivity

Since the Buchs workshop, a further assessment has been undertaken on protected areas: ALPARC determined which protected areas can play a more important role for biodiversity and connectivity, and produced a map of such areas.

The criterion for including certain protected areas was their protection status. Thus the map includes the core zones of national parks, nature reserves and Italian nature parks. Italian nature parks were included due to their specific mission for nature protection. Other categories of protected areas were not included because their protection measures were considered to be too weak to ensure effective conservation of biodiversity and connectivity. Future analyses will have to take into consideration this new layer.

5. Suggestions for extension of priority area boundaries

A review of Kai Elmauer's study *Analysis of priority conservation areas in the Alps: biodiversity, threats and opportunities for conservation* (2004, revised 2006) was undertaken, looking for indications of needed corridors or for potential suggestions to extend the boundaries of priority areas.

During this study, experts and literature sources were consulted to collect information about the 24 priority areas identified in the Alps. As a result of these consultations, some suggestions had emerged.

Given that most of these are justified based on habitat continuity or presence of stepping-stones for some species, these suggestions could now be considered for the identification of new connection areas.

6. Comparison with other corridors suggested

In September 2002, during the Alpbach meeting, some corridors – additional to those already identified in Gap – were recommended for consideration. These were:
– the Rheintal
– the Brenner (which should continue south from Bolzano compared to the line identified in Gap)
– the Ennstal
– a corridor from Innsbruck to Munich.
These recommendations should be considered for the future refining of the maps of connection areas.

Moreover, in April 2006 WWF Austria recommended that two more connection areas be considered: the Lech River Valley and the Isar River Valley, originating from priority areas P and O respectively and both extending north of the boundary of the Alpine Convention.

Results

The work undertaken before, the Buchs workshop is a first test on how to proceed and therefore methodology and results should be validated and reviewed by other experts.

Notwithstanding these points of caution, there is general agreement that the analyses undertaken so far definitely are a good first start and a basis for further work.
In addition, the activities started the thinking on connection areas at pan-Alpine scale.

Advice of experts on the GIS analyses required

The following analyses were suggested to validate the identified main connection areas using the opportunity/feasibility principle. The order of the actions also indicates the prioritization.

1. Comparison of the identified connection areas with the natural land cover classes of CORINE/PELCOM and others (natural areas) without taking into account the protection status
2. Comparison of the identified connection areas with the existing national and international protected areas (preferably taking into account their IUCN status), or with other areas recognized as important for

biodiversity or connectivity (e.g., Ramsar sites, IBAs, acknowledged important areas for migratory species, etc.). For protected areas, it would be appropriate to use ALPARC's map of the protected areas important for biodiversity and connectivity
3. Comparison of the identified connection areas with the wilderness (remote) areas
4. Comparison of the identified connection areas with human population pressures
5. Comparison of the identified connection areas with existence of barriers.

<u>Suggestions for next steps and methodology</u>

The overall method used in the workshop for the identification of connection areas consisted in focusing on the ecological need principle and then use the feasibility/opportunity principle to assess the feasibility of the connection areas identified, also paying attention to the political acceptance principle. Using only one of the methods proposed would be too limited and would not use all available information. Therefore the following next steps and methodological procedure are suggested, for each of the three different principles:

Step 1. **Ecological need principle.** This is the most significant principle according to which connection areas should be identified. It will therefore be important to strengthen the ecological underpinning of the connection areas identified and to assess if any area or criterion is missing. Based on the worksheets of the Buchs workshop, the biological reason for identifying several of the corridors in the Alps is already known. Yet, the following actions are still required:

– Action 1: Check the identified connection areas (and the reasons why they were identified) with the available habitat-related information (valley bottoms, land cover, other areas, etc.) to verify if their location should be slightly modified (e.g., to include an important wetland). Focus especially on the comparison of the identified connection areas with the distribution of the natural land cover classes of CORINE/PELCOM and others (without taking into account protection status)
– Action 2: Check if any macro-corridor proposed by the experts' input (and accounted for) is not covered by the connection areas identified
– Action 3: For a large part of the Alps – but not for the entire Alpine range – important dispersal routes for large carnivores and herbivores are known (e.g., Austria and Switzerland, see for example the work by Völk and Zimmermann) as well as migratory routes or sites important for bird migrations (e.g., Italy, see for example the work by Fornasari; Zenatello, Baccetti & Serra). Consider gathering this information for the entire Alps to fill in the gaps.

Other analyses to consider are:
– Analysis to identify areas with a high coverage of non-fragmented habitats outside priority areas for different ecological groups (the most obvious ones are the species related to forests)
– Analysis of the landscape permeability for different ecological groups with a different sensitivity for barriers (different models are available to do this)
– Analysis to identify areas with a high diversity of landscape structure
– Analysis to identify areas with range in elevation or climatic circumstances.

With the above analyses, the best possible connection areas based on the ecological need principle can be identified.

Step 2. **Feasibility/opportunity principle.** This is the principle according to which the identification and location of the preliminary connection areas can be validated (this principle is used to assess the feasibility of the connection areas already identified according to the ecological need principle). The following additional GIS analyses should be run, divided into two categories: I. Convergence with existing instruments; II. Divergence from existing settlements and infrastructures:

<u>I. Convergence with existing instruments</u>
– Action 1: Verification of whether any identified connection area is part of a national REN
– Action 2: Comparison of the identified connection areas with the existing national and international protected areas (preferably taking into account their IUCN status or based on the ALPARC map of protected areas important for biodiversity and connectivity, or with other areas recognized as important for biodiversity or connectivity (e.g., Ramsar sites, IBAs, etc.)
– Action 3: Comparison of the identified connection areas with the wilderness areas or areas where natural disturbances can occur. (Wilderness areas – or remote, unfragmented areas – are areas relatively undisturbed and removed from human impact. They often correspond to mountain tops, glaciers, etc., and can therefore even represent natural barriers. Here biodiversity is not necessarily "rich" (e.g., wilderness areas per se are not priority areas for biodiversity, but they may include important focal species.)

<u>II. Divergence from existing settlements and infrastructures</u>
– Action 4: Comparison of the identified connection areas with human population pressures and existence of barriers.

With the above analyses, the most feasible connection areas based on a feasibility/opportunity principle can be selected.

Step 3. **Political acceptance principle.** This principle should not be used to validate or identify the connection areas, but to add a new layer of information to the areas identified, to better describe and possibly rank them, to assess how they can be communicated to external audiences and to devise the most appropriate measures for implementation. The following analyses should be undertaken:
– Action 1: Evaluate the overlap of the connection areas identified with existing national and regional networks. This will provide an indirect indication of the support to identified connection areas that could be expected from decision-makers in certain countries
– Action 2: A criterion should be established to integrate existing official national and regional ecological networks into the identification of connection areas. The issues to explore in depth are the different scale, data and approaches used for the various RENs, as well as the difference in approach among them and the identification of connection areas of Alpine importance.

Follow-up

Wider consultation with the scientific community
– Organizers propose a formal methodology based on the conclusions above
– Experts contacted in the wider consultation will evaluate the connection areas already identified and propose new ones based on the formal methodology developed and on their knowledge
– Given the complexity of the issues and the need to harmonize and coordinate the different approaches currently existing for the ecological network of the Alps, it was decided to launch a common project to further explore some of the matters. The different approaches currently existing include: the main potential connection areas of the Alps (Consortium), the corridors among protected areas (ALPARC and Alpine Convention), the Pan-European Ecological Network (European Center for Nature Conservation) and the national and regional RENs (individual countries or public administrations). The objective of such a project would be to define a standard, formal methodology to identify ecological networks at different spatial scales, and to agree upon a conceptual framework for the coexistence and interaction of such different approaches, when they are all warranted. The formal methodology can then be used also for other large regions in Europe.