CONSERVATION AND MONITORING OF BIODIVERSITY IN ITALY

The conservation of biodiversity is a particularly multifaceted issue, strictly correlated to both the dynamism of natural ecosystems and the complexity of human activity.

In Italy, the idea of a "system of protected areas" was clear only to a few in the 1980s, while for the general public the concept of "protected areas" was connected to parks already in existence, understood as exceptions in a network of territorial management dominated by urban and economic development (AGRICOLA, 1997). This fact transpired notwithstanding the scientific community had already conceived the concept of territorial protection in its entirety, which was not in contrast with socio-economic activities, but rather a basis for development, especially in marginal areas (GIACOMINI and ROMANI, 1984; ABBATE *et al.*, 1989; BLASI, 1989), thus distinguishing "conservation" from simply "preservation as the idea of conservation, particularly in the late 1970s and early 1980s, made one think of immobilisation, the stabilisation of a status quo, as if the living reality could be subtracted from the dynamism which instead constitutes an essential feature in open systems, Valerio GIACOMINI (1976) introduced the concept of "active conservation" to highlight the importance of man, his organic and functional inclusion in the ecosystem, and more generally speaking, to indicate the importance of a systemic vision in the management of resources. Thus, *active conservation* was thus defined as a particular form of management in which ecosystem functions predominated over the productive functions of anthropic systems.

In regions where man's presence is greatly felt such as Italy, conservation actions, projects, and programming must refer to functional and dynamic models that arise from the application of scientific research (BLASI *et al.*, 1997; BLASI, 2003).

The system of parks and nature reserves in Italy developed over several decades in an unplanned manner, in complete contrast to the Natura 2000 network. In fact, Italy has environmental systems, that are well represented in protected areas such as mountains, while others such as the coastal one, are poorly represented (BLASI, l.c.). The system of protected areas is based on *in-situ conservation* that is undoubtedly one of the most essential conservation actions of biodiversity. In fact, species conservation, which is linked to the complete utilisation of habitats and landscapes, can only be guaranteed by having vast areas of the territory in a natural and semi-natural state (see chapter *Biodiversity and Landscape*). Intact habitats that are connected to one another and to their associated ecological processes are most important to biodiversity, thus planning for such protection requires a landscape-scale perspective. The study and knowledge of landscape implies an analysis of its complexity in order to reconstruct the processes that have led to the current situation and which can be used to define the dynamic models to apply to future scenarios.

National parks and protected areas play a fundamental role in biodiversity conservation along with landscape conservation. This can be achieved by elaborating programmes that are capable of producing development models that can be applied throughout the territory that conjugate the conservation of our natural, historic, and cultural patrimony through encouraging of new forms of production.

Over the last few years, attempts have been made to find new forms of *ex-situ conservation* of plant life to flank the international network of botanic gardens. In the past, the traditional aims of these institutes, whose establishment in some cases dates back many years, was research, training, and dissemination. While today, they are also

establishing *germplasm or seed banks* capable of conserving vulnerable and endangered plant life that are of great conservation interest.

To this regard, *Planta Europa* - a network of European organisations (non-governmental and governmental) carries out a very important role in the conservation of wild plants and their habitats. Planta Europa (the European application of Plantlife International) and the Council of Europe have in fact elaborated the European Plant Conservation Strategy (EPCS) in line with CBD Decision VI/9 to carry out and promote a Global Strategy for Plant Conservation (GSPC).

IN-SITU CONSERVATION

[Fabio Renzi]

This system currently covers 1,748 communes (22% of Italian communes) of which 68% have less than 5,000 inhabitants, 283 consortiums of mountain municipalities (79% of the total) 98 provinces (95% of the total) and all the regions. National Parks alone cover 462 communes, 82 consortiums of mountain municipalities, 39 provinces, and 18 regions. This vast extent of protected territory is the result of actions and intervention that dates as far back as 1922.

THE FIRST NATIONAL PARKS: 1922-1968

The first Italian National Park, that of Gran Paradiso, was established in 1922 in a royal hunting reserve donated to the nation by Vittorio Emanuele III, fifty years from the founding of Yellowstone Park (the first protected area in the world set up in 1872), followed in 1923 by the founding of the Abruzzi National Park.

If one considers that on May 24th 1909 the Swedish Parliament approved the first framework law on National Parks in Europe (<http://www.sweden.se/templates/cs/Article_2265.aspx>), then it is easy to appreciate the effort made at the time to keep pace with the emergent forms of nature conservation. It is worth noting that among the objectives of the Abruzzi National Park at the time of its establishment, there was that of promoting tourism that today is called sustainable along with the more customary naturalistic, scientific, and educational aims. The Circeo National Park followed in 1934, and in the following year, the Stelvio National Park was founded, and then after a very long pause the Calabria National Park was established in 1968. In the period following WW II, Italy attempted to reconstruct the nation and guarantee conditions of civil, social, and cultural life that witnessed a long-awaited and necessary economic development in the construction of territorial infrastructures and industrial settlements. The economic boom years brought mass consumption and well-being to millions of Italians. However, the awareness of the need to manage and orient the processes of economic development and to safeguard the cultural and natural heritage of the nation was the prerogative of a select few, and only later did it spread in society. Moreover, the attention paid to the nation's natural heritage, and more generally to the environment, was much lower than that paid to cultural heritage and Italy's architectural patrimony. If small areas of nature were safeguarded it was, above all, in virtue of the fact that they were considered beautiful landscapes. Moreover, the environment and nature are concepts, which, unlike landscape, do not come within the Italian Constitution, where only recently have they been introduced. It is for this reason that the first generation of protected areas in Italy that began in 1922 continued up to the late 1960s. The only other activity regarding territorial protection taken in this space of time was the establishment of nature reserves that increased in number to 121 promoted by the *Corpo Forestale dello Stato* (National Forest Service) from 1959 to 1979, covering 92,416 hectares. These areas were almost exclusively established either on State property or on that of the Forestry, and managed by the Forestry itself. In this panorama, the initiatives launched by the Autonomous Board of the Abruzzi National Park in charge of the Park administration were innovative. The first attempts of ecotourism were carried out which involved the local communities in managing the protected area, along with the promotion of conservation projects regarding important species such as the wolf and the bear.

A BOOST FROM THE REGIONS: 1967-1990

The regions first began to create new protected areas in the early 1970s. In 1967, the confines of the Parks of Adamello Brenta and Panaveggio-Pale di San Martino were demarcated in the Trento Province's town planning. In 1973, the Lombardia Region put forward the first framework law on protected areas that provided for the elaboration of a regional plan for parks, the institution by law of the plan itself, and the territorial planning of the park. In 1974, the first regional park in Italy, that of Valle del Ticino in Lombardia was established, followed in 1975 by the first regional park in Tuscany, that of Maremma. In that period, the regions of Liguria, Lazio, and Piemonte also adopted framework laws on protected areas. The principal innovative features of this period were based upon a new conception of the role and function of protected areas, which was influenced by the cultural and political climate of those years that witnessed much greater social and institutional participation at all levels. In this period, the institutional provision of decentralisation from the State to the regions took place. The definitive delegation of power and competencies, such as the one on regional protected areas came about with DPR 616/77. These were the years in which the regions made a great effort in defining their territorial and environmental assets, such as the regional system of protected areas. The park plan is recognised as the fundamental instrument for management. The protected area is characterised as an institutional autonomy open to the participation of several actors (administrators, environmentalists, farmers).

However with the passing of time, the innovative spirit of the Regions progressively fades and loses its strength, also due to the fact that a national framework law on protected areas that DPR 616/77 provided for by 1979 had still not been approved by Parliament. Thus, hopes for general planning legislative tools dwindled in the early 1980s. The role of the Regions is further weakened as neo-centralist measures are approved such as the *FIO* (Occupational Investments Funds) promoted by the Ministry of Public Works, with the aim of creating infrastructures in the immediate future – which in many cases meant the construction of unserviceable sewage works and the cementing of riverbeds. Moreover, the first amnesty for infringements of building regulations was endorsed by Parliament that created great controversy among the political world. The general public gradually becomes more aware of environmental issues and new environmental associations are set up along side the historical ones. Reaction from cultural and environmental circles becomes stronger which leads Parliament to promulgate laws in order to try to stem the situation. With Law 979/82, several dispositions are promulgated regarding the protection of the sea and the coast and marine reserves are set up. With Decree Law 312/85, then converted into Law 431/85 (more commonly known as the *Galasso Law*), urgent dispositions were issued to safeguard areas of particular landscape interest and the regions were called upon to draw up landscape plans. This was the turning point in government policies regarding the territory and the environment. The Galasso Law innovates and extends the concept of landscape, underlining its importance from a naturalistic and ecological point of view. Moreover, it assigns Regions the task of planning landscape conservation initiatives that are to be incorporated into all planning actions. This Law forms the foundation on which many protected areas can be delimited, instituted, and provisionally regulated. It is in this climate that the Ministry for the Environment Land and Sea Protection is established with Law 349/86, and so takes the place of the Ministry for Agriculture and Forestry concerning national and inter-regional protected areas. In 1986, the Chernobyl disaster further increases the general public's awareness of environmental issues and more generally, of issues regarding the quality of life, which is sanctioned in 1987 with the referendum which brought a halt to nuclear power plants in Italy. With the 1988 financial act followed by Law 305/89 on the three-year programme for environmental conservation, the National Parks of Pollino, Dolomiti Bellunesi, Monti Sibillini, Golfo di Orosei, Delta del Po, Casentinesi Forests, Tuscan Arcipelago, and that of Aspromonte were established.

THE NATIONAL FRAMEWORK LAW ON PROTECTED AREAS: 1990S TO THE PRESENT

Law 394/91 introduced the concept of the national system of protected areas to which all national, regional and local protected areas come under, both public and private ones, including marine and land protected areas. This system was created through instruments such as the *Carta della Natura* (Nature Map), *Linee fondamentali di assetto del territorio* (Basic Guidelines for Country Planning) and the *Programma triennale* (Three-year Programme) which gives a national, strategic dimension to protected area policies. Coordination of the various institutional bodies involved (Ministry for the Environment Land and Sea Protection, other Ministries and Regions) is carried out through the Committee for Protected Areas. The Three-year Programme and the Committee were abolished under DLG 112/98, which conferred the functions and administrative tasks previously carried out by the State to the regions and to local councils. Moreover, DLG 112/98 assigned the role of the Committee to the *Conferenza Stato–Regioni* (State-Regions Conference). Other innovative aspects of this framework law are those that refer to the national park authority; it regulates its autonomy, and its governing body in which local authorities, regions, environmental associations, the scientific community, and the Ministries for the Environment and Agriculture are represented. An increasingly important role has been played throughout the years by the park community that convenes the interested regions and local authorities in order to make decisions, especially with regards to issues of local development. The peculiar institutional features of the Law only partly explain the success and spread of protected areas in Italy in the 1990s. Another innovative feature of Italy's experience in this sector is the capacity of the parks to confront themselves with the specific elements of the territory; consequently, parks are at the same time a tool for conservation as well as for local development, thus anticipating the orientation and ideas proposed by the Durban Action Plan for the worldwide system of parks.

It is in this direction that both scientific research and the initiatives set up from the *Rete Ecologica Nazionale* (National Ecological Network) go hand in hand. This Network comes within the 2000-2006 structural funds programme for conservation and local development policies that landscape, biological, cultural and productive diversity issues.

Last of all, the Italian experience is characterised by the attempt to surpass, both conceptually and in practical terms, an insular conception of protected areas giving life to large-scale projects of great environmental and cultural importance such as the *Appennino Parco d'Europa - APE, Coste Italiane Protette, Progetto Itaca "La rete delle isole minori del Mediterraneo", Convenzione delle Alpi* (the Apennine Park of Europe, Protected Italian Coasts, the Network of Minor Mediterranean Islands, and the Alps Convention).

The challenge is that the system of protected areas, if opportunely planned, coordinated and managed, can also reach beyond individual sites to promote on-the-ground protection in adjacent areas and out across the landscape (Secretariat of the Convention on Biological Diversity, 2004). Indications from the Durban Congress indicate that these networks, though inserted in national contexts, could promote coalitions and supranational aggregations capable of providing a contribution to resolving to problems that are of a greater scale; in this sense, a project such as APE could be the first applicable experimentation that regards the entire mountain area in the Mediterranean region.

The V IUCN World Parks Congress held in September 2003 with the theme "Benefits Beyond Boundaries" took note of the exponential growth in the number of protected areas in the world over the last decade. In fact, the Durban Action Plan states that since the previous World Parks Congress, held in Caracas in 1992, the number of protected areas and their total extent have more than doubled, covering more than 12% of the Earth's land surface (with an additional 10% of specially protected areas in Antarctica), and that the number of natural World Heritage sites has increased from 101 to 172, which confirms a growing recognition of the ties between world populations and the environment. Italy has provided one of the most formidable contributions to this result in terms of increase in numbers, distribution and extent of protected areas.

PROTECTED AREAS AND THE NATURA 2000 NETWORK[1]

[Piera Di Marzio, Eugenio Dupré]

From recent data provided by the Italian Ministry for the Environment Land and Sea Protection, there are a total of 772 protected areas in the Official List of Protected Areas (5th Update 2003, No. 144 of the Official Gazette 04/09/2003):

- 25 National Parks,
- 20 Protected Marine Areas and Marine Reserves,
- 146 State Reserves
- 3 Other National Protected Areas,
- 105 Regional Parks (nature, fluvial, urban, etc.),
- 335 Regional Reserves
- 141 Other Regional Protected Areas (land and marine oases, nature areas, nature reserves, natural monuments, fluvial areas, protection zones, biotopes, protected areas of local interest, equipped territorial parks, municipal parks, urban and suburban parks, equipped park areas, botanic gardens).

Therefore, the total extent of protected areas amounts to 10% of the national land territory (Table 7.1).

Moreover, among the categories of protected areas there are:

- 50 wetland areas designated under the Ramsar Convention of 02.02.71,
- 503 SPAs (under the Birds Directive 79/409/EEC,
- 8 UNESCO MAB Reserves: Collemeluccio–Montedimezzo (1977), Circeo (1977), Miramare (1979), Cilento and Vallo di Diano (1997), Somma Vesuvio and Miglio d'Oro (1997), Valle del Ticino (2002), Tuscan Islands (2003), Selva Pisana (2004),
- 63 biogenetic reserves under Council of Europe Resolution 17 adopted by the Council of Ministers on 15.03.1976.

In addition to these protected areas, there are also 2,256 proposed Sites of Community Importance (pSCI) (Tables 7.2 and 7.3), and subtracting the overlap of areas with the above-mentioned protected areas, the total extent of protected territory reaches about 19%.

A requisite for registration to *EUAP* (Official National List of Protected Areas) is the presence of a managing board (criteria established with Resolution 1/12/1993 of the *Comitato Nazionale per le Aree Naturali Protette* - National Committee for Protected Areas).

The non-*EUAP* protected areas in Italy cover 420,860 hectares (Table 7.4). They make up a total of 382 areas to which another 29 areas should be added that have been established though not officially recognised (MARCHETTI *et al.*, in press).

In Italy, the management of protected areas registered in *EUAP*, is entrusted to numerous authorities:

- autonomous park authorities or provisional management committees (National Parks under the superintendence of the Ministry for the Environment Land and Sea Protection),
- the *Corpo Forestale dello Stato*, whose principal task is that of surveillance in national parks, while it manages the biogenetic reserves on the basis of Framework Law 394/91,
- a consortium between the State and the two autonomous Provinces of Trento and Bolzano (Stelvio National Park),
- the ex *Azienda di Stato per le Foreste Demaniali (ASFD)* for the State nature reserves instituted by the Forestry Administration prior to 1986 (with the exception of those that come within the national parks, managed by the park authorities),

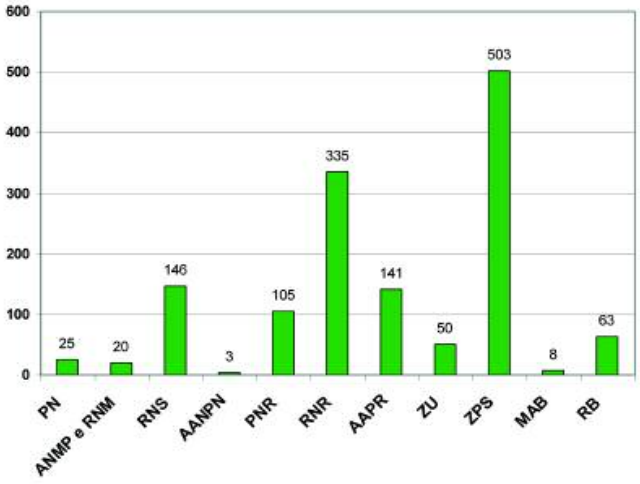

Fig. 7.1 - The number of protected areas in Italy. Abbreviations: PN = National Parks; ANMP = Protected Marine Areas; RNM = Marine Reserves; RNS = State Reserves; AANPN = Other National Protected Areas; PNR = Regional Parks; RNR = Regional Reserves; AAPR = Other Regional Protected Areas; ZU = Wetlands; ZPS = Special Protection Areas; MAB = UNESCO MAB Reserves; RB = Biogenetic Reserves.

[1] Updated to June 2005.

Table 7.1 - Regional allocation of the EUAP areas, 2004 (Ministry of the Environment and Territorial Protection).
Page 413 up

Table 7.2 - Regional allocation of the SPAs and of the SCIs, 2004 (Ministry of the Environment and Territorial Protection).
Page 413 down

REGION	MAR	AANP	AANPN	PNR	PNZ	PNZ_m	RNR	RNS	Total (ha)
ABRUZZO		1,161		55,452	254,983		8,159	18,471	338,227
BASILICATA				34,935	89,160		4,181	1,008	129,284
CALABRIA	15,641				234,699		590	16,674	267,604
CAMPANIA	1,531	730	223	132,240	186,700		11,915	2,082	335,422
EMILIA ROMAGNA		198		48,861	47,385		1,833	8,085	106,362
FRIULI VENEZIA GIULIA	29			46,826			7,242	380	54,477
INTER-REGIONAL			2,358,023						2,358,023
LAZIO	4,187	4,028		113,801	5,589		42,889	25,502	195,996
LIGURIA	3,109	20		22,505	3,860		22	15	29,531
LOMBARDIA		1,349		60,749	59,693		10,489	250	132,530
MARCHE				21,509	69,887		304	6,112	97,813
MOLISE		1,227					51	1,274	2,551
PIEMONTE		5,572		94,911	45,178		11,336	3,507	160,504
P.A. BOLZANO				110,902	55,971		897		167,771
P.A. TRENTO		1,661		80,970	17,661		1,241		101,533
PUGLIA	20,390	605		132	119,076			11,286	151,490
SARDEGNA	70,511	3,249		5,200	84,160	15,407			178,527
SICILIA	76,831	4		184,798			87,116		348,748
TOSCANA		70,174		54,268	23,488	56,121	30,630	12,039	246,720
UMBRIA		4,449		40,571					45,020
VALLE D'AOSTA				5,766	37,154		519		43,439
VENETO				50,576	14,733		2,129	19,678	87,115
Total (ha)	**192,229**	**94,428**	**2,358,247**	**1,164,973**	**1,349,378**	**71,528**	**221,544**	**126,363**	**5,578,689**
Total (% of national territory)	-	**0.3%**	-	**3.9%**	**4.5%**	-	**0.7%**	**0.4%**	**9.8%**

Legend: MAR = marine protected areas; AANP = other natural protected areas; AANPN = other marine natural protected areas; PNR = regional natural parks; PNZ = national parks; PNZ_m = national parks, sea quota; RNR = natural regional reserves; RNS = State natural reserves.

REGION	SPAs n. sites	SPAs surface (ha)	SPAs %	SCIs n. sites	SCIs surface (ha)	SCIs %	Natura 2000 sites Surface (ha)	Natura 2000 sites %
****Abruzzo**	4	288,408	26.6%	52	252,479	23.3%	386,598	35.7%
Basilicata	17	35,590	3.5%	47	55,462	5.5%	54,503	5.4%
Bolzano	16	140,234	19.0%	41	138,872	18.8%	147,413	19.9%
Calabria	4	27,081	1.8%	179	85,609	5.6%	103,544	6.8%
Campania	27	214,804	15.7%	106	362,530	26.5%	387,216	28.3%
Emilia-Romagna	61	155,608	7.0%	113	194,713	8.8%	236,546	10.7%
Friuli Venezia Giulia	7	80,965	10.3%	62	125,782	16.0%	126,227	16.1%
****Lazio**	42	263,681	15.3%	183	143,169	8.3%	298,109	17.3%
Liguria	7	19,615	3.6%	124	141,517	26.2%	142,835	26.4%
Lombardia	22	95,641	4.0%	175	204,720	8.6%	259,080	10.9%
****Marche**	29	130,894	13.5%	80	98,943	10.2%	144,957	14.9%
****Molise**	2	4,789	1.1%	88	100,962	22.6%	101,756	22.8%
***Piemonte**	37	129,720	5.1%	124	258,891	10.2%	270,980	10.7%
Puglia	16	207,127	10.6%	77	465,446	23.8%	465,848	23.4%
Sardegna	9	16,137	0.7%	92	426,250	17.7%	427,093	17.7%
Sicilia	47	125,213	4.8%	218	384,889	14.9%	384,889	14.9%
Toscana	60	126,185	5.5%	120	282,491	12.3%	292,511	12.7%
Trento	14	13,558	2.2%	152	151,626	24.4%	151,626	24.4%
Umbria	7	47,116	5.6%	99	96,425	11.4%	120,291	14.2%
***Valle d'Aosta**	5	60,709	18.6%	26	71,048	21.8%	109,493	33.6%
Veneto	70	304,248	16.5%	98	355,954	19.3%	375,850	20.4%
Total	**503**	**2,487,323**	**8.2%**	**2.256**	**4,397,778**	**14.6%**	**4,987,366**	**16.5%**

* as the site IT1201000 is partly assigned to Piemonte and in part to Valle d'Aosta, the surface calculation has been carried out by allotting to each Region the portion of the site effectively falling inside its territory.

** as the site IT7110128 belongs to Abruzzo, Lazio and Marche and the site IT7120132 to Abruzzo, Lazio and Molise, the surface calculation has been carried out by allotting to each Region the portion of the site effectively falling inside its territory.

- governing boards of State nature reserves which were established after 1986 (under the control of the Ministry for the Environment Land and Sea Protection),
- regional authorities, provincial and town councils, private and public administration consortiums, the *Azienda Regionale Foreste Demaniali della Sicilia, Comunità montane* (consortium of communes in mountain areas), environmental associations, and universities (for protected areas that they themselves establish on their own property).
- The Secretariat General of the Italian Presidency (Castelporziano State Nature Reserve).

What clearly emerges from this outline is that the network of protected areas could be reviewed and perhaps extended. In fact, there are mountain environments that are very well represented in Italy, while coastal and alluvial habitats are poorly represented.

	SPAs		SCIs		Natura 2000 sites
Biogeographical region	**n. sites**	**surface (ha)**	**n. sites**	**surface (ha)**	**surface (ha)**
Alpine	101	976,962	452	1,246,325	1,507,758
Continental	180	444,423	537	667,442	763,357
Mediterranean	222	1,065,939	1,267	2,484,011	2,716,251
Total	**503**	**2,487,323**	**2,256**	**4,397,778**	**4,987,366**

Table 7.3 - Biogeographical regional allocation of the SPAs and of the SCIs, 2004 (Ministry of the Environment and Territorial Protection).

REGION	Total HA	Total NUMBER	% HA	% NUMBER
Basilicata	339.49	1	0.08	0.26
Calabria	517.79	3	0.12	0.79
Campania	6,561.07	5	1.56	1.31
Emilia-Romagna	1,512.57	14	0.36	3.66
Friuli-Venezia Giulia	734.07	2	0.17	0.52
Lazio	8,350.61	11	1.98	2.88
Liguria	17,211.46	32	4.09	8.38
Lombardia	362,176.12	55	86.06	14.40
Marche	96.24	1	0.02	0.26
Molise	1,284.98	3	0.31	0.79
Piemonte	533.70	5	0.13	1.31
Puglia	420.017	5	0.10	1.31
Sardegna	11,312.18	21	2.69	5.50
Toscana	5,929.96	10	1.41	2.62
Trentino-Alto Adige	3,813.87	212	0.91	55.50
Veneto	66.16	2	0.02	0.52
Total	**420,860.927**	**382**	**100.00**	**100.00**

Table 7.4 - Regional allocation of non-EUAP areas (MARCHETTI *et al.*, 2005).

Bibliography

ABBATE G., AMADORI M., BLASI C., GIGLI M.P., MARCHETTI M., (1985) 1989 – *Quale futuro per le aree marginali dell'Italia centro-meridionale*. In: "*Il bosco nell'Appennino. Storie, vegetazione, ecologia, economia e conservazione del bosco appenninico*." Centro Studi "Valleremita". Fabriano: 407-419.

AGRICOLA B., 1997 – Relazione introduttiva. Atti dei convegni Lincei, 132: 7-8.

BLASI C., 1989 – *Conservazione attiva, protezione cosciente e pianificazione del territorio*. Urbanistica 97, Rivista trimestrale dell'INU: 32-34. Franco Angeli, Milano.

BLASI C., 2002 – *I Parchi che ridisegnano l'Italia*. In: "*Il paesaggio è mobile*", inserto del Sole 24 ore del 18 agosto 2002: 23-24.

BLASI C., 2003 – *Conservazione della biodiversità e rete ecologica d'Italia*. Atti della II Conferenza Nazionale delle Aree Naturali Protette, vol. 3°: 11-12. Ministero dell'Ambiente e della Tutela del Territorio – Regione Piemonte. Ed. Comunicazione, Forlì.

BLASI C., FILPA A., DE DOMINICIS V., 1997 – *Come collegare la pianificazione territoriale con la conservazione della biodiversità e l'ecodiversità del paesaggio*. S.It.E Atti, 18: 573-574.

GIACOMINI V., 1976 – *L'uomo e la biosfera, una ampliata visione ecologica*. CNR MaB Italia, Report, 1. Roma.

GIACOMINI V., ROMANI V., 1984 – *Uomini e parchi*. Angeli Editore, Milano.

MARCHETTI M., CULLOTTA S., DI MARZIO P., 2005 – *I Sistemi di Aree Protette in Italia e il loro contributo alla conservazione forestale*. L'Italia Forestale e Montana, 4: 559-579.

SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY, 2004 – *Biodiversity issues for consideration in the planning, establishment and management of protected area sites and networks*. Montreal, SCBD, 164 pages and i to iv. (CBD Technical Series, no. 15).

EX-SITU CONSERVATION

[Anna Scoppola]

The Conservation of Biological Diversity (CBD) ratified by Italy in 1994 foresees, among other things, *in-situ conservation* (Art. 8) and *ex-situ conservation* (Art. 9). These two approaches, though independent are not antithetical but complementary; in particular, the *ex-situ* conservation of biodiversity consists in conserving genetic diversity and organisms outside their natural habitats.

The CBD stresses the priority of long-term *in situ* conservation of biodiversity, though noting that this is not always possible. Hence vital role played by botanic gardens is recognised not only for *ex situ* techniques carried out at these institutes (Figure 7.2) which, among other things, provide a greater survival rate to endangered *taxa* in nature, but also because they promote scientific research, provide material for plant reintroduction, develop hybridisation and sustainable use programmes, and promote environmental education.

Plant species such as *Anthurium leuconeurum* Lem., *Caralluma arenicola* N.E. Br., *Encephalartos woodii* Sander, *Eucalyptus steedmanii* C.A. Gardner, *Euchlaena perennis* A.S. Hitchc., *Lysimachia minoricensis* Rodr., *Myosotis ruscinonensis* Rouy, *Sophora toromiro* (Phil.) Skottsb and many others which are extinct in nature today, are safely cultivated in botanic gardens. Botanic gardens cultivate more than 80,000 vascular plant species that represents about 30% of the total number of flora (IZCO, 1997).

However, time has shown that the traditional system of cultivating isolated or small groups of plants has not proved effective. In the last 15-20 years, the nature and dimension of today's environmental problems and the modern concept of species had led botanic gardens to review their conservation objectives and define new strategies which concern not only their collections of living plants, but also the establishment and maintenance of facilities for field gene banks, plant banks in vitro, pollen banks and the stocking of seeds and genes in germplasm banks, cryoconservation (-195°C) and others (ROSSI *et al.*, 2004).

Even though the environmental conditions of the natural place of origin must be considered, conserving living specimens or creating germplasm, seed, pollen banks, etc., is quite different from conserving natural populations, as any type of ex-situ conservation will, in any case, be partial and will always correspond to a certain domestication of the taxon. In fact, nothing can substitute the action of natural factors, nor is it possible to simulate natural selection or avoid genetic erosion (IZCO, 1997).

In 1984, two world organisations, IUCN and WWF set up a World Conservation Strategy (WCS) that gave life to the Botanic Gardens Conservation International (BGCI) with the aim of assisting, promoting and coordinating botanic gardens at a worldwide level. Two other important international agencies in this field are the International Plant Genetic Resources Institute (IPGRI) and the International Association of Botanic Gardens (IABG). The need for greater coordination in ex-situ con-

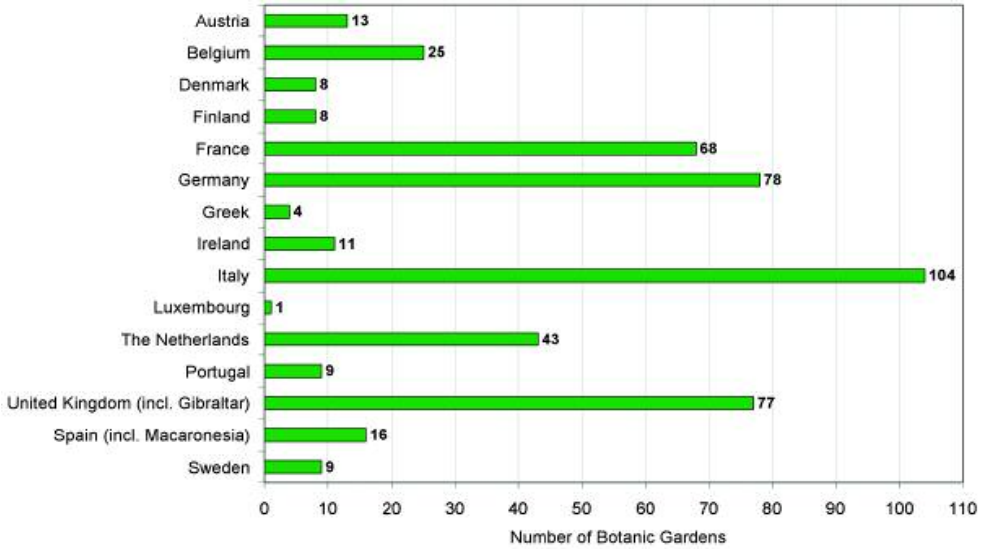

Fig. 7.2 - Botanic Gardens in the European Union (CHENEY *et al.,* 2000, modified)

servation measures to counteract the loss of germplasm of spontaneous species has been recognised by various European Community and national bodies, such as Spain, the European Union and others, and by the Council of Europe with the establishment of a network of independent organisations, non-governmental and governmental, working together to conserve European wild plants and fungi *Planta Europa*.

In 2000, the European Consortium of Botanic Gardens (SBI; edited by, 2001), the body created in 1994 by the Botanic Gardens Conservation International (BGCI) and the International Association of Botanic Gardens (IABG), elaborated an Action Plan for Botanic Gardens. Several objectives are presented in the Action Plan to ensure in-situ conservation and assessment (objective C1), to develop management of ex-situ collections (objective C2), and to develop management and analysis of data and information on plant diversity (objective C3). Botanic gardens are invited to extend the traditional role they hold with regards to ex-situ conservation and to guarantee that the conservation of diversity is both sufficiently genetically controlled and documented, so as not to compromise the evolution potential of conserved material. Moreover, botanic gardens should serve as possessors and providers of information on conservation from the collection, maintenance and exchange of data regarding all aspects of plant diversity and its conservation. Therefore, botanic gardens should evolve into centres for the collection and distribution of the most important data regarding plant biodiversity and conservation (SBI, l.c). Moreover, in the aforesaid Plan, a series of actions to undertake were provided to ensure a form of management within the institute that promotes biodiversity conservation, the sustainable use of plant resources and the elaboration of national and international policies to safeguard biodiversity. All this demonstrates how deeply the issue of biodiversity conservation is felt and how it has become central to future policies of botanic gardens throughout the world (SBI, l.c).

Notwithstanding the considerations expressed for more effective in-situ conservation, ex-situ conservation (if carried out with the necessary guarantees and according to the objectives suggested by the BGCI) therefore offers evident advantages and could counter the extinction of many *taxa*. Hence, good planning becomes fundamental: the priority of conservation must be established in relation to the importance of the loss that is encroaching, thus the more important the information and the genetic diversity of an endangered *taxon*, the higher the priority (Figure 7.3). For example, the only species of a certain genus (monospecific genus) such as *Woodwardia radicans* (Figure 7.4) present in Italy, has priority over another that belongs to a genus with a great many species. This is even truer for species used as foodstuff or for medical purposes, or if they are a wild family member of cultivated species for these uses (see section *Genetic diversity of plant species of agricultural interest*), or if the plant is of scientific interest (relict species, endemic species), etc, (Table 7.5).

Fig. 7.3 - Conservation priority of threatened *taxa* (Bramwell *et al.*, edited by, 1987).

Fig. 7.4 - *Woodwardia radicans* (L.) Sm., priority species listed in Annex II of Habitats Directive, is considered vulnerable in Italy where it is conserved *in-situ* in Campania, Calabria and Sicilia and *ex-situ* in several botanic gardens, including the Botanic Gardens of Catania and Portici (Photo by Botany Department, University of Catania).

Wild species	
1	rare and endangered,
2	of economic interest,
3	for ecosystem restoration and reintegration,
4	key species, for example those of particular importance for ecosystem maintenance and stability,
5	taxonomically isolated species, whose disappearance would represent a serious loss to science.
Cultivated species	
1	primitive cultivars (local varieties),
2	semi-domesticated plants.

Table 7.5 - Priorities to be followed in the conservation of indigenous species and of species of economic and alimentary interest.

The first germplasm bank created in botanic gardens in the United Kingdom in the late 1970s soon proved to be one of the best tools to prevent biodiversity loss and guarantee a future to endangered species in their sites of origin. At present, there are about 250 germplasm banks in the world, essentially found in industrialised countries, and in particular, in Anglo-Saxon countries. About one hundred are in Europe, with eighty situated in Northern European countries and about twenty in the Mediterranean region. The most important germplasm bank on a worldwide scale today is the British Millennium Seed Bank (MSB) of the Royal Botanic Gardens in Kew - one of the leading centres for advice and actions on aspects of plant and fungal conservation (<http://www.rbgkew.org.uk/sedbank/msb.html>).

One of the aims of the Seed Bank Project is to collect and conserve 10%, over 24,000 species of the world's seed-bearing flora principally from the drylands by 2010, whose progressive loss due to desertification could harm the survival of local populations (Linington, 2001).

Numerous germplasm banks have been set up in Italy in the last few years with the aim of conserving spontaneous seeds, especially in local contexts. The most important are situated in Lucca, (which is also the oldest), Padova, Germplasm Institute of Bari (CNR), Calgary and Palermo. They all participate in the GENMEDOC Project - *Creation d'un reseau de Centres de conservation du materiel génétique de la flore des régions méditerranéennes de l'espace MEDOC* (P.I.C. Interreg III B - Méditerranée Occidentale) whose aim is to collect and conserve seeds of endemic, rare or threatened *taxa*, elaborate germination and multiplication protocols of selected material, and study populations that are the structure of priority habitats listed in the Directive 92/43/EEC. Last of all, worthy of mention are the germplasm banks of the *Museo Tridentino di Scienze Naturali* (Trentino Seed Bank), University of Pavia (Lombardia Seed Bank, LSB) and that of Pisa which have been partners in an important thematic research network made up of 19 institutes operating in the continent called ENSCONET (European Native Seed Conservation Network) since 2004. This Network, funded by the European Union in the context of the VIth Framework Programme (2004-2008), is headed by the Royal Botanic Gardens in Kew. ESCONET seeks to improve ex-situ conservation of seeds of threatened spontaneous European flora (Rossi *et al.*, 2005). The drying and storage techniques along with the equipment used in germplasm conservation are essentially the same at all centres; the standard drying procedure requires air with 15% UR at 15°C for at least 30 days (I.S.T.A., 1985), freezers with internal drawers in which airtight containers are placed, and no-frost refrigerators for the definitive storage at temperature of -18°C. However, there are slight variations from one institute to the next regarding the storage procedures and temperatures for germplasm conservation.

Many local governments (e.g. Piemonte Region, Lombardia Region, Autonomous Province of Trento, Toscana Region, Autonomous Region of Sicilia, etc) have emanated norms in recent years that foster the establishment of germplasm banks as ex-situ conservation centres for biodiversity.

Recently, the *Museo Tridentino di Scienze Naturali*, the *Centro Regionale Flora Autoctona* of Lombardia along with the Botanic Gardens of the Universities of Pavia and Pisa created an *ad interim* body to coordinate the activities of a group of institutes for germplasm conservation which has drawn up a protocol for the establishment of an Italian Network of Germplasm Banks for the *Ex-situ* Conservation of Spontaneous Italia Flora entitled *RIBES*, undersigned by 19 institutions in Italy (<http://www.unipv.it/labecove/rete_germplasma.html>) (Table 7.6).

As a result of the ex-situ conservation strategies, there are now many cases of species that were once threatened being reintroduced into their natural habitats. However, we do not as yet know the exact distribution and real vulnerability status of many plants in Italy (Bonafede *et al.*, 1999; Rinaldi, 1996), some of which are threatened such as the *Saxifraga hirculus* L., *Stachys brachyclada* Noë, *Asparagus pastorianus* Webb et Berthel, and others that are probably extinct (Scoppola and Spampinato, 2005).

Region	Institution	Operative since
Piemonte	*Germplasm bank of South-West Alps*	2003
Lombardia	*Lombardia Seed Bank LSB*	2001
Trentino - Alto Adige	*Trentino Seed Bank TSB*	2002
Veneto	*Germplasm bank of Padova Botanic Garden*	1992
Liguria	*Laboratory for the conservation of Ligurian plant diversity*	In preparation
Toscana	*Germplasm bank of Pisa Botanic Garden*	1995
	Germplasm banks of Livorno	2000
Marche	*Germplasm bank for the conservation of amphiadriatic species*	In preparation
Lazio	*Germplasm bank of Viterbo Botanic Garden*	In preparation
	Germplasm bank of Rome Botanic Garden	In preparation
Abruzzo	*Germplasm bank of Gran Sasso*	In preparation
	Germplasm bank of Majella	In preparation
Molise	*Germplasm bank of Molise*	In preparation
Puglia	*Germplasm bank of CNR of Bari*	1970
Basilicata	*Germplasm bank CODRA Mediterranea S.r.l.*	'90s
Sardegna	*Germplasm bank of Sardegna (BG-SAR)*	1997
Sicilia	*Germplasm bank of Palermo Botanic Garden*	1993
	Germplasm bank of Catania Botanic Garden	In preparation
	Germplasm bank of the Mediterranean®, ONLUS	1997

Table 7.6 - Institutions that have subscribed the RIBES protocol of intent: (Italian network of germplasm banks for *ex situ* conservation of Italian spontaneous flora) (<http://www.unipv.it/labecove/rete_germoplasma.html>).

EX-SITU CONSERVATION OF FAUNA

[Nicoletta Tartaglini, Eugenio Dupré]

Council Directive 1999/22/EC of 29 March 1999 on the keeping of wild animals in zoos was recently adopted by Italy through Legislative Decree 21 March 2005, No.73 published in the Official Gazette No. 100 of 2 May 2005.

The aim of the Decree is to contribute to safeguarding biodiversity, thus observing the obligation to adopt measures for ex-situ conservation, contained in Article 9 of the Convention on Biological Diversity (CBD). The zoos in Italy that must establish *ex-situ* conservation, through managing an extended and renewed gene pool of animal populations in captivity, have been identified. This management covers exchange and loan plans for reproduction in the context of specific national and international projects regarding the conservation of species and their natural habitats and the safeguarding of the well-being of animals. Moreover, parameters will be set for the recognition of national and international research programmes on environmental education and the conservation of endangered species and their habitats.

The new norm, moreover, indicates that zoos must promote and carry out education and awareness-raising programmes for schools and the general public about biodiversity conservation.

Bibliography

BACCHETTA G., BOCCHIERI E., COSTA M., GÜEMES J., MOSSA L., 2001 – *Studio e conservazione della diversità vegetale nel Mediterraneo occidentale insulare: il progetto Cagliari-Valencia.* Inform. Bot. Ital., 33 (1): 240-243.

BONAFEDE, F., DALLAI D., MAFFETTONE, L., DEL PRETE, C., 1999 - Marsilea quadrifolia *L. in Emilia-Romagna: distribuzione, ecologia e problematiche di conservazione integrata* in situ/ex situ. Report IV Congr. SBI: 20, Università di Ferrara.

BRAMWELL D., HAMANN O., HEYWOOD V.H., SYNGE H. (a cura di), 1987 – *Botanic Gardens and the World Conservation Strategy.* IUCN Academic Press. London.

CHENEY J., NAVARRETE NAVARRO J., WYSE JACKSON P., 2000 – *Action Plan for Botanic Gardens in the European Union.* BGCI, Richmond.

FRANKEL O.H., BROWN A.H.D., BURDON J.J., 1995 – *The conservation of plant biodiversity.* Cambridge University press. 299 pp.

GIVEN D.R., 1994 – *Principles and Practice of Plant Conservation.* Chapman & Hall. London. 292 pp.

HAMANN O. (a cura di), 1992 – Ex situ *Conservation in Botanical Gardens.* Opera Botanica, 113. Copenhagen.

I.S.T.A., 1985 – *International rules for seed testing.* Seed Sciences and technology, 13: 299-355.

IZCO J., 1997 – *Jardines botánicos*. In: IZCO J. (a cura di), Botánica: 581-606. McGraw-Hill, Interamericana. Madrid.

LININGTON S., 2001 – *The Millenium Seed Bank Progect*. In: RUSHTON B.S., HACKNEY P., TYRIE C.R. (a cura di), Biological Collections and Biodiversity.

LUCAS G., SYNGE H. (a cura di), 1978 – *The IUCN Red Data Book. IUCN*. Gland. Switzerland. 540 pp.

PLANTA EUROPA (a cura di), 2002 – *European Plant Conservation Strategy. Conserving plant diversity*. Plant life, june 2002: 18-29. CBD. London, U.K.

RINALDI G., 1996 - *Progetti di reintroduzione a livello locale del Giardino Botanico di Bergamo*. Riv. Mus. Civ. Sc. Nat. «E. Caffi» di Bergamo, 18: 37-46. Bergamo.

ROSSI G., DELLAVEDOVA R., MONDONI A., PAROLO G., 2004 - *Le banche del germoplasma per la conservazione delle specie vegetali rare e minacciate*. QUASAM, Quaderni di Biodiversità, 2 (2003): 77-86. Università di Bologna.

ROSSI G., MONDONI A., PAROLO G., DOMINIONE V., LEVA G., BODINI F.M., 2005 – *La Banca dei semi delle piante autoctone lombarde (Lombardy Seed Bank, LSB): una nuova struttura per la conservazione* ex situ *del germoplasma*. Archivio Geobot., 7 (2) (2001), suppl.. Pavia. 38 pp.

SBI – Gruppo di Lavoro per gli Orti Botanici e i Giardini Storici (a cura di), 1995 – *Orti Botanici e Strategia della Conservazione (ed. italiana)*. WWF, IUCN, BGCS. Pisa, 63 pp.

SBI – Gruppo di Lavoro per gli Orti Botanici e i Giardini Storici (a cura di), 2001 – *Piano d'Azione per i giardini Botanici nell'Unione europea (ed. italiana)*. Inform. Bot. Ital., 33, suppl. 2. 66 pp.

SCOPPOLA A., SPAMPINATO G. (eds.), 2005 - Atlante delle specie a rischio di estinzione in Italia. CD-Rom allegato al volume: SCOPPOLA A., BLASI C. (eds.), Stato delle conoscenze sulla Flora vascolare d'Italia. Palombi Editori. Roma.

<http://www.unipv.it/labecove/rete_germoplasma.html>

<http://www.rbgkew.org.uk/sedbank/msb.html>

SYNTHESIS ON THE MAIN NATIONAL AND INTERNATIONAL MONITORING PLANS AND PROGRAMMES

[Roberto Caracciolo, Chantal Treves]

The monitoring and the consequent evaluation of the status and foreseeable evolution of biodiversity is more than just a commitment for the institutions of every nation: it is an obligation. This obligation has been sanctioned at a global level by Art. 7 of the Convention on Biological Diversity, and by Art. 11 of the EU Directive on Flora, Fauna and Habitats at a European Community level.

Even though numerous initiatives have been launched regarding these issues, which in the case of international bodies principally had the aim of promoting the harmonisation of this activity in various nations, the picture is still quite complex and in many cases, the problem is faced at a very rudimentary level to say the least.

When one speaks of environmental monitoring, the concept of network applied to issues such as air quality, water quality, climatology, etc. is quite well known and clear-sighted. For example, the apparatus that measures gas emissions in squares and streets in our cities are familiar to all, and the purpose is quite clear.

While the situation is quite different when considering the biological component of the environment, that is, the wealth of animal and plant species, the habitats in which they live, and more generally speaking, the environment. In this case, the possibility of keeping this component under control and verifying changes over time is a much less perceptible, not only to the general public, but also at times, also to those who have a technical-scientific background.

Both in the administrative sphere as well as in the technical-scientific one in Italy, the distribution of competence in this field, on the one hand, has created several methodological divergences and the overlapping of initiatives, while on the other, it has kept the attention focused on this issue.

The section that follows provides an overall picture, though brief, of past and programmed initiatives, with particular reference to environmental agencies that primarily deal with environmental monitoring in Italy.

The description will cover both methodological and operational aspects.

Moreover, these initiatives have been greatly influenced from the experience conducted in Europe, which have constituted a priority reference point for the development of monitoring activities.

Worthy of mention at this point is the European Environment Agency – the EEA. This European Union body is the main information source for those involved in developing, adopting, implementing and evaluating environmental policy and also to the general public. A description will be provided of the methodological approach developed by the EEA, as well as a description of several biodiversity monitoring projects conducted in Europe.

The information provided below was principally taken from official documentation produced by *Agenzia Nazionale per l'Ambiente* – now known as APAT (Italian Agency Environmental Protection and Technical Services), through the project *Centro Tematico Nazionale Conservazione della Natura* – (CTN-CON, now known as CTN-NEB) and by the European Environment Agency, through the corresponding project: European Topic Centre on Nature Conservation (ETC-NC, now known as ETC-NPB).

MONITORING IN THE CONTEXT OF INFORMATION MANAGEMENT

The knowledge-based instruments at our disposal are the indispensable premises that support environmental policies in that they allow informed decisions about improving the environment, integrating environment considerations into economic policies and moving toward sustainability.

For this reason, APAT carries out scientific and technical activities in the national interest to protect the environment, and is subject to the guidelines and oversight of the Ministry for the Environment Land and Sea Protection. It operates on the basis of a three-year programme, annually updated, that sets objectives, priorities and resources, in implementation of the directives of the Ministry for the Environment Land and Sea Protection. APAT is integrated into a network-type system, the Environment Agency System, which today includes Regional (ARPA) and Provincial (APPA) Agencies, established by special regional laws. It is an example of a consolidated federal system, which combines direct knowledge of the local area and local environmental problems with national environmental protection and prevention policies, so as to become a point of institutional and technical/scientific reference for the entire country.

What clearly emerged from the initial phase of setting up this network-type system (ANPA, 1998a; ANPA, 1998b) was the need to integrate the two principal functions carried out by the agencies: to promote organisational, methodological and educational activities and to optimise the instruments for the planning and reporting of environmental control and monitoring activities (Figure 7.5). This integration must consider numerous aspects:

- the important conceptual change in the approach to environmental protection activities, as well as the results of the new orientations of environmental policies in all contexts, brought about by implementing aspects of Agenda 21 which was a thorough and broad-ranging programme of actions demanding new ways of investing in our future to reach global sustainable development in the 21st century. Its recommendations ranged from new ways to educate, to new ways to care for natural resources, and new ways to participate in designing a sustainable economy;
- the transfer of environmental information management to environmental agencies;
- the decision to entrust these agencies with the task of interfacing national and international environmental bodies and institutions;

Great efforts have been made toward developing and experimenting a system or framework for describing and quantifying the environment nationally and internationally, with the development of various approaches, applied separately or in combination. The *media approach* organises environmental issues from the perspective of the major environment components of air, land, water, and the human-made environment. The *stress-response approach* focuses on impacts of human intervention with the environment (stress) and the environment's subsequent transformation. The *resource accounting approach* aims at tracing the flow of natural resources from their extraction from the environment, through successive stages of processing and final use, to their return to the environment. Ecologic approaches include a variety of models, monitoring techniques and ecological indices in a broad field that could be characterised as "statistical ecology" or "ecological statistics."

A framework that was accepted by many agencies in the early 1990s and now widely used is the *Pressure-State-Response* (PSR) framework developed by the OCED in 1993. In contrast to the earlier *stress-response* model, which unrealistically tried to make one-to-one linkages among particular stresses, environmental changes and societal responses, the OECD PSR framework does not attempt to specify the nature or form of the interactions between human activities and the state of the environment. It distinguishes three broad types of indicators: indicators of environmental pressures that describe pressures from human activities exerted on the environment, including the quality and quantity of natural resources; indicators of environmental conditions that relate to the quality of the environment and the quality and quantity of natural resources; and indicators of societal responses that are measurements which show the extent to which society is responding to environmental changes and concerns.

This framework forms the basis for ongoing developments of the *Driving Force-State-Response* (DSR) framework and the *Driving Force-Pressure-State-Impact-Response* (DPSIR) framework (see Figure 7.6), both of which are still under review and development. In the DSR framework, the term *pressure* has been replaced by that of *driving force* in order o accommodate more accurately the addition of social, economic and institutional indicators. In addition, the use of the term *driving force* allows that the impact on sustainable development may be both positive and negative as is often the case for social, economic, and institutional indicators.

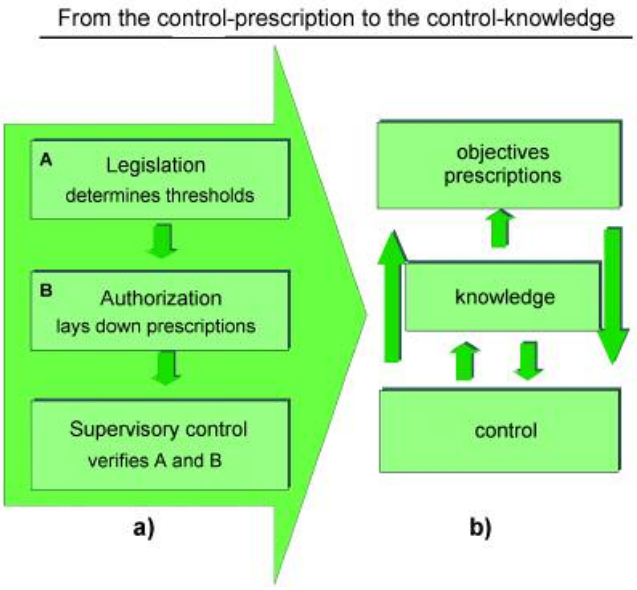

Fig. 7.5 - Scheme representing the evolution of the control functions in the environment: from an isolated and final event of a prescriptive process to a "control-knowledge-response" circular scheme.

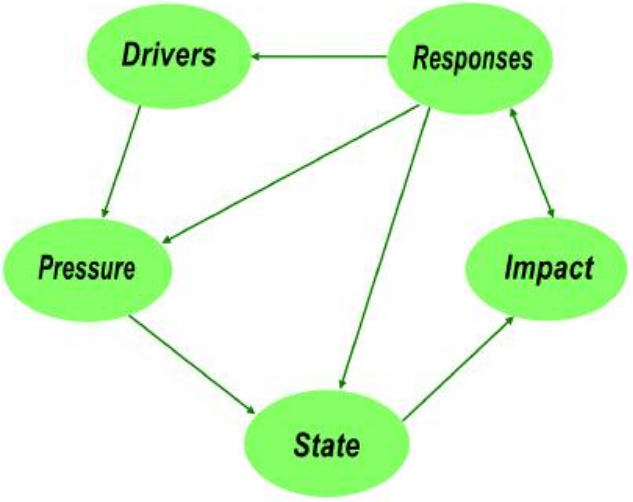

Fig. 7.6 - The DPSIR assessment framework proposed by the European Agency as an extension of the PSR Model (*Pressure, State, Response*) developed by the OCSE. It provides a diagram of the cause-effect relationships between interacting components of social, economic, and environmental systems.

Even this model is changing, and the EU is now looking at the DPSIR framework developed by the European Environment Agency, which has been adopted by the APAT to build the environmental data system (APAT, 2002a).

The DPSIR framework organises related environmental data and information in five categories showing the relations of cause and effect. The priority aim is the *state*, i.e. the set of physical, chemical and biological qualities of environmental resources (air, water, soil, etc.). The state is altered by *pressure*, comprising whatever tends to degrade environmental state (emissions to the atmosphere, waste production, industrial discharge, etc.) mostly caused by human activities (*driving forces*) – industry, agriculture, transport, etc., as well as natural ones. This alteration produces effects (*impacts*) on the health of human beings and animals, on ecosystems, economic damage, etc. to deal with impacts, *responses* are prepared, i.e. countermeasures (such as laws, intervention plans, directives, etc.) in order to: act on the infrastructures, as the *driving forces* of environmental degradation; reduce *pressures;* act on *state* through safeguarding and/or remediation interventions; limit *impacts* through compensating interventions.

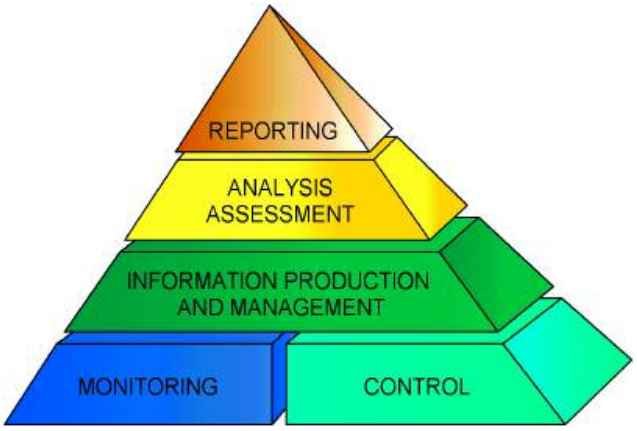

Fig. 7.7 - The Knowledge Pyramid.

NATIONAL AND SUPRANATIONAL PROGRAMMES ON MONITORING BIODIVERSITY

As briefly mentioned beforehand, in implementing specific dispositions provided by laws and directives, a series of initiatives have been set up to improve the capacity to monitor the present levels and trends of biological diversity understood as a priority environmental resource to conserve.

These initiatives have been planned by single nations as well as at the supranational level. As far as the last-mentioned is concerned, and particularly with regards to the European Union, efforts have primarily been directed towards developing adequate and effective methodological and integration instruments to guarantee a more straightforward integration of data from various nations. Consequently, this would allow a European monitoring network to be set up without much prior intervention from singular nations.

At a world-wide level, the development of indicators and networks to monitor biodiversity have been guided by Article 7 of the Convention on Biological Diversity.

The procedures to plan initiatives at a national level were set out in a work programme during the Third Meeting of the SBSTTA held in Montreal in 1997.

The implementation of this programme received greater impetus with Decision V/7 of the Fifth Conference of the Parties to the Convention on Biological Diversity, held in Nairobi in 2000. This Decision, in fact, involves the preparation of the state of advancement of the initiatives promoted by the Executive Secretary of the CBD.

At a European level, the first report relative to the Convention on Biological Diversity regarded the state of implementation carried out by European Community institutions (EC, 1998a).

The European Commission's strategy (EC, 1998b) as regards to biodiversity and the consequent Action Plan (EC, 2001) adopted by the European Parliament on March 14th 2002, underlined the importance of a set of indicators to monitor the progress made on implementing sectoral policies.

The following is a brief review of the European initiatives, commencing with the methodological approach given to monitoring activities by the EEA, with pilot studies in biogeographical regions, followed by an outline of the first network experiences both in Italy and abroad.

The Pilot Studies of the European Environment Agency

The European Topic Centre on Nature Protection and Biodiversity (ETC/NPB, formerly European Topic Centre for Nature Conservation, ETC/NC), is one of five EEA's topic centres. It assists the EEA in its work of collecting, analysing, evaluating and synthesising information relevant to national and international policies for the environment and sustainable development. European Topic Centre on Nature Conservation (ETC-NC) has been active since its first operative plan in 1995.

Indications on procedures were partly amended during an important international meeting held in Wageningen (Holland) in April 1995.

Moreover, on that occasion the experts, more than reaching a methodological approach that could be generalised at a European Community level, recognised that the knowledge and methodology available was absolutely inadequate to define these instruments. Moreover, they were in agreement on the need to set up a challenging research programme articulated into an adequate number of pilot studies, each one with specific objectives to identify the characteristics of biodiversity in different biogeographical regions in Europe.

The study was based on an approach at three levels, to estimate biological diversity in relation to land cover, habitat and species, in areas representative of the biogeographical and ecological regions.

The planning and implementation of the study was carried out by the ETC-NC and its members.

The complete study programme was conducted in two stages. The first was conceptualised as an approach to evaluate biodiversity based on top-down assessment criteria in a standardised manner.

An attempt was also made in reference to the species abundance to identify the so-called hot-spots in Europe.

In order to overcome the methodological limitations and obstacles encountered in Stage I, Stage II, focused on selected habitats types and was conceived to generate more specific information regarding qualitative and quantitative aspects of biodiversity.

Both these stages had the objective of analysing the interdependence between different forms of biodiversity (in terms of species, habitat and landscape), geographical conformations, and human activity as components of an indicative and integrative model to manage environmental data at a European level.

In particular, specific techniques were developed to establish the scale and scenario of a methodology that meas-

ured and monitored biodiversity with reference to:

- a description of biological diversity for each ecological region, as a combination of factors, such as:
  1) species diversity
  2) habitat diversity
  3) landscape diversity
  4) crop and farm animal diversity;
- the incorporation of data on land use and other human activities as factors that influence the state and trend of biodiversity from the socio-economic and ecological point of view;
- the emphasis on priority species listed in international treaties, directives and conventions such as the conventions of Bern and Bonn and the Natura 2000 Directive;
- the elaboration of specifications which orientate the monitoring procedures in facilitating the application of information directly to the territory;
- a test to verify the appropriateness of international classification systems;
- the identification of the lack of data and development of specific techniques for the future use of international data.

The information collected not only regarded physical, biological, and socio-economic aspects of the area selected for the pilot studies, but it also concerned the development of methodological tools, references to the quality and structure of the necessary data to describe the state and trends of biological diversity.

Italy participated in the pilot study programme through ANPA, as member of the ETC-NC Consortium. A brief description of the study is provided in the following section.

International and European Initiatives

A large group of experts participated in the electronic-conference *Auditing the Ark- Science-based Monitoring of Biodiversity* run in September 2002 organised by BioPlatform[1] to discuss issues such as identifying the major reasons for monitoring biodiversity, discussing some existing and planned biodiversity monitoring programmes, communication strategies, the feasibility of developing a core programme of biodiversity monitoring across Europe.

In the conclusions to the conference, the main issues that emerged from discussions participants of this meeting were outlined, stressing the need to develop a core programme of biodiversity monitoring across Europe.

Moreover, the participants agreed on the three main reasons to set a biodiversity monitoring programme:

- to measure the state and trends in biodiversity at various levels by establishing standardised protocols and appropriate strategies,
- to quantify the impact of man's activities, policies and actions not directly connected to conservation and the sustainable use of biodiversity,
- to evaluate the impact of policies relative to conservation and the sustainable use of biodiversity.

Even if the fundamental role of the Convention on Biological Diversity was recognised in developing an international monitoring system, its weakness was demonstrated by the fact that only 1% of the Contracting Parties had implemented wide-ranging monitoring programmes and only 6% had identified the national biodiversity indicators, thus calling for other actions to be undertaken.

Many of the initiatives presented at the e-conference are in the planning stage, and in some cases, are being implemented.

Unfortunately, the absence of an adequate level of coordination that would optimise the efforts and progress towards common goals was confirmed.

Table 7.7 lists some examples of biodiversity monitoring programmes reviewed by B. DELBAERE in a very recent report conducted for the European Topic Centre for Nature Protection and Biodiversity (ETC/NPB).

Among the most interesting experiences indicated in the table, worthy of mention is *Euring* (the European Union for Bird Ringing) the oldest monitoring network in Europe with the largest databank of European ringing recovery data stored in a standard format. It organises and standardises European scientific bird ringing ensuring collaboration among national centres. Among its most active members there is the Italian Ringing Scheme coordinated by the Italian Institute for Wild Fauna (INFS).

The network utilises reference standards for the marking and signalling of ringed birds, collects information on species physical characteristics of ringed individuals and the routes taken, thus providing a valuable support for the management and conservation of birds.

Another programme of great interest, which sees the participation of Italy, is the joint EU/ICP Forests Monitoring Programme funded by the UNECE (United Nations Economic Commission for Europe) and the EU. This project

[1] BioPlatform is a thematic network that supports the European Platform for Biodiversity Research Strategy (EPBRS), which is a forum of institutional bodies and authorities that support biodiversity research in Europe.

Network name	Network responsible subject	Geographical area	Monitored elements	Objectives of interest	Beginning of activity	Number of sampling sites
EuroMAB Network and UNESCO/MAB BRIM Programme	UNESCO	Europe and North America (30 countries)	Reserves of the Biosphere	control of the status and of the transformation trends of biodiversity at the international scale	207	
IWC International Waterbird Census	Wetlands International	Europe, Africa, Middle East (47 countries)	Bird species	control of the status and of the transformation trends of biodiversity at the international scale, with reference to the Ramsar conv.	1967	More than 5,000
Joint EU/ICP Forests Monitoring Programme	European Commission and UNECE	Europe (37 countries) reference of	forests	Control of the air pollution effects on the forests; European CON.ECO.FOR	1994	Level I, 6,000 Level II, more than 860
Network Natura 2000	European Commission, Environmnent DG	EU	Species, habitats, Natura 2000 sites	verification of adoption of the Habitat Directives (Dir. 92/43/EEC) and Birds (Dir. 79/409/EEC)	in preparation (programmed phase a)	2,827 SPAs and 14,901 SCIs
Biomare	Consortium of centres of marine research (23 partners) led by NIE-CECO (NL)	Europe	ecosystems	control of the status and of the transformation trends of marine biodiversity		37
EON2000+ - Earth Observation for Natura 2000+	Consortium of centres of research led by GEOSPACE, Austria	EU	habitats and land uses in the Natura 2000 sites	Ecosystem monitoring, land uses and Natura 2000 sites	2001	
EPN - European Phenology Network	Consortium of centres of research led by Wagningen University	Europe	species	control of the status and of the transformation trends of biodiversity		
EURING	Euring	Europe	Species of ringed birds	Control of birds' populations and migrations; European reference of the National Ringing Centre	1899	many stations
EUROWATERNET	EEA, ETC/WTR	Europe	in particular, biotic elements of the ecosystems of superficial water courses (inland waters, transition, marine)	Monitoring the quality of water courses; European reference of the Monitoring Network of superficial waters quality	in preparation (programmed phase a)	More than 3,500 rivers; more than 1,000 lakes

To be continued on the following page

GLORIA-Europe Global Observation Research Initiative in Alpine Envionments	Network coordinated by Vienna University	Europe (expanding onto the mountains of the other continents)	ecosystems	Impact of climate change on mountain ecosystems	2001	18 target regions
Integrated monitoring on a landscape scale for rural areas in Europe	ECOLAND, Pan-European Forum for Countryside and Landscape Monitoring	Europe	Rural landscapes			
MARS European Network of marine research stations	MARS Network (around 40 institutes)	Europe	Coastal ecosystems	control of the status and of the transformation trends of biodiversity at the international scale	1994	

Table 7.7 - Examples of monitoring programmes concerning biodiversity at the international and European level (ETC/NPB, 2002).
Following from previous page

was created to analyse the possible negative effects of atmospheric pollution on forest systems, with reference to the UNECE Convention on Long-Range Transboundary Pollution (CLRTAP) and the EEC Regulation on the Protection of Forests Against Atmospheric Pollution.

At present, 39 countries participate in this joint EU/UNECE Forest Monitoring Programme, all working closely to build an integrated environmental monitoring system that is one of the largest and most effective in the world. The main objectives of the Programme are:

- to provide a periodical report on the spatial and temporal variations in forest condition in a European and national large-scale systematic network;
- to contribute to a better understanding the relationships between the state of forest ecosystems and anthropogenic (in particular air pollution) as well as natural stress factors through intensive monitoring of a number of selected permanent observation plots spread over Europe and to study the development of important forest ecosystems in Europe;
- to contribute to forest policy at a national, Pan-European and global level regarding the effects of atmospheric pollution, climatic change and biodiversity for sustainable forest management (ETC/NPB, 2002).

The sites in the IPC Forest (International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) monitor forest condition across continental Europe, using two different monitoring intensity levels. All the 6,000 sites of Level I annually assess crown condition on a 16?16 km grid, while specific sites also measure soil condition and chemistry, foliar nutrient status, and meteorological conditions. Level II entails an

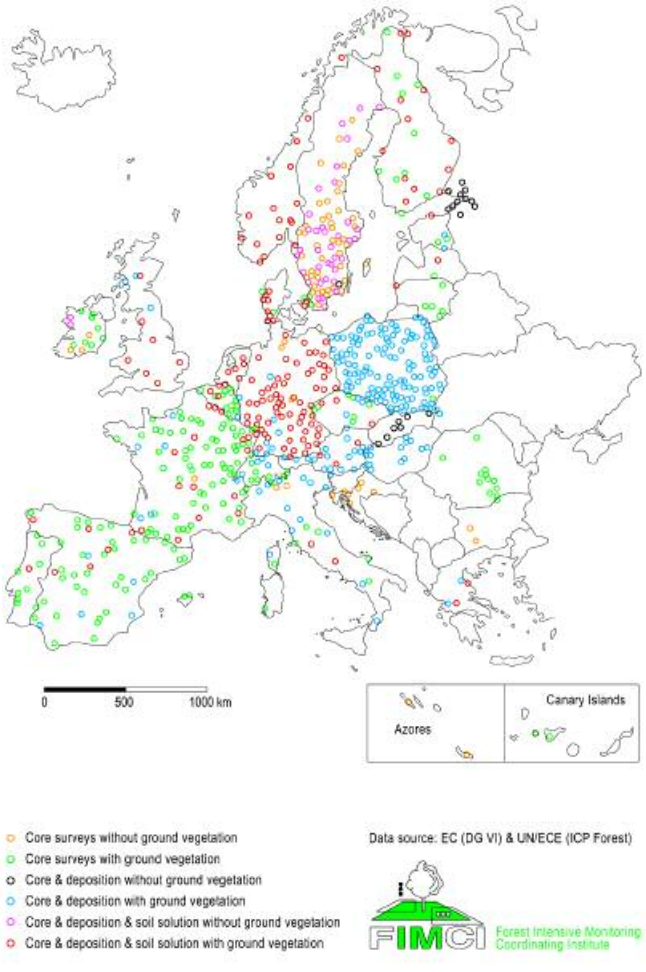

Fig. 7.8 – Sample Plots of the IPC Forest Monitoring Network (Eu/FIMCI web site, redrawn).

intensive monitoring programme of some 860 plots that enable case studies in the major forest types of Europe.

As far as the biodiversity of forest systems is concerned, IPC Forests analyses the ground vegetation and air pollutant deposition of 674 sites (Figure 7.8) (EC UNECE, 2002).

Worthy of mention is the monitoring, assessment and reporting of conservation status under the Habitats Directive 92/43/EEC, which is not only of importance in relation to the implementation of the Directive itself, but is a crucial building block for an overall trends assessment in Europe. Monitoring of conservation status is an obligation arising from Article 11 of the Habitats Directive for all habitats and species of Community interest. Consequently this provision is not restricted to Natura 2000 sites and data need to be collected both in and outside the Natura 2000 network to achieve a full appreciation of conservation status. Article 17 of the Habitats Directive provides the framework for the submission of information on progress in implementation of the Directive: Member States are required to draw up implementation reports every six years following the date at which the Directive came into force. The Directive sets out the framework for the time, content, compilation, and distribution of a composite version of these national reports.

The overall objective of the Directive is to achieve and maintain favourable conservation status for all habitats and species of Community interest and to contribute towards maintaining biodiversity of natural habitats and of wild fauna in the European territory of the Member States. Monitoring must therefore lead to a clear picture of the actual conservation status and its trends on various levels and indicate the effectiveness of the Directive in terms of approaching and reaching this objective.

For this reason, the Habitats Committee of the European Commission has approved a framework for reporting, monitoring and assessment of conservation status of single habitats and species. The information requested in the framework regards the present status and trend of certain parameters: the range, population and habitat as regards to species; the range and area occupied as regards to habitats.

Another network of great interest is GLORIA (Global Observation Initiative in Alpine Environments), a monitoring project on Alpine flora and climatic changes coordinated by the Institute of Ecological and Biological Conservation of the University of Vienna. The GLORIA Network is arranged along a world-wide setting of target regions, though it is operative above all in Europe where 18 summit observation sites in 13 European countries were established in 2001, its first year of activity.

The purpose of GLORIA is to:

- document changes in biodiversity and vegetation patterns caused by climate change in the world's high mountain ecosystems.
- estimate the potential risk of biodiversity utilising a world-wide assessment of the ecological consequences caused by climate change;
- assess the impacts of climate-change-induced biodiversity and habitat losses and associated effects on ecosystem functioning.

The GLORIA multi-summit approach is a widely applicable basic monitoring strategy. The observation sites are at mountain summits, arranged along an elevation gradient. This sequence of summit sites represents readily identifiable points along a pronounced climatic gradient from tree line to the upper limits of plant life. Information is collected on all of the most important mountain plant species included within the 16 x 1 m quadrants used at each summit.

An example of a monitoring network: the National Swiss Network

The monitoring networks analysed up to this point were of a thematic nature, they deal with particular aspects, and collect information on specific *taxa* or ecosystems also in relation to certain elements of disturbance, and with the aim of identifying the trend of global process-

Fig. 7.9 - GLORIA Project: flora survey in the Mont Avic Nature Park, in Valle d'Aosta (Photo by ARPA Valle d'Aosta).

es. However, they are not intended to give an overall picture of the state of biodiversity in a given country.

Instead in answering to this need, a national wide-ranging biodiversity monitoring network was established in Switzerland. Switzerland was a signatory to the Convention on Biological Diversity (CBD) in Rio, and as such has undertaken an international obligation to maintain and promote biodiversity. These tasks, however, first require changes in biodiversity to be identified. Article 7 of the CBD therefore correctly requires the Parties to Convention to monitor biodiversity in their countries. Thus, the Swiss Agency for the Environment, Forests and Landscape (SAEFL) launched the Biodiversity Monitoring Programme in Switzerland (BDM) for this purpose.

The data collected provides fundamental information on the biological richness of the nation, and are considered the basis on which to define protection measures and to evaluate the effectiveness of territorial policies.

After a long preliminary stage begun in 1993 in which the SAEFL commissioned a working group to develop a scientifically based concept in which the methodological approach was defined, and after attaining the necessary funds, organising a series of activities including the training of data collectors, the first data collection got underway in 2000. This stage is to last five years, in which time all the sampling areas are to be surveyed. All the sampling sites are expected to have been surveyed once by 2006. this will make Switzerland one of the first countries to have reliable information on the state of its biological capital.

Two sampling grids covering the whole of Switzerland have been created specially for this programme. The first encompasses some 500 sampling areas, each measuring one square kilometre, the other 1,600 sampling areas that are much smaller in size. This is where selected species groups are surveyed. For most species groups, the sampling area measures 10 square metres. In the first year of operation for the DBN 95 area areas of one square kilometre were identified and 326 sites covering 10 square metres each. The annual cost of running the BDM effectively will be 1.8 million Swiss Francs.

The monitoring programme, based on the internationally recognised PSR model (Pressure-State-Response) developed by the OECD in 1993, comprises a total of 32 indicators that should ensure significant information on the biodiversity of the nation to be obtained. The BDM comprises not only indicators of state, such as change in the size of valuable habitats, but also factors that could affect biodiversity, such as changes to the nutrient supply in the soil.

The programme also distinguishes between three levels of biodiversity. Genetic diversity, species diversity and habitat diversity (Table 7.8). Genetic diversity is restricted to livestock races and agricultural plant varieties; while only one quantitative and one qualitative indicator have been defined for habitat diversity as it is difficult to define ideal states or desirable and undesirable changes, given its complexity and the difficulty to record delimitation.

The programme focuses principally on species diversity; starting from the consideration that in the last 50 years the most significant changes in biological diversity have not only regarded rare species but also common ones, such as the hare; thus the monitoring programme gives greater attention to widely-spread species, and focuses less on those endangered species already included in the Red Lists.

Species diversity can be described on three different levels: species diversity of a habitat α, species diversity of a region β, and species diversity of a country γ. The programme utilises various indicators to analyse the three levels and considers the presence of rare or possibly threatened species to analyse γ diversity, the presence of species with abundant populations to analyse α diversity, and an analysis of how species are distributed throughout a vast territory though not necessarily with large populations for β diversity.

Vascular plants, mosses, and lichens, along with various animal groups from birds to mammals, and insects from plecopters, orthopters to dragonflies and butterflies are surveyed in the sampling grids. In most cases, the survey records their presence/absence in the sampling area but does not consider population consistency.

Data that are useful for the elaboration of pressure and response indicators generally come from institutional databanks. The findings are compiled and processed by a central coordination office, published periodically and made available to users.

More recent trends

At this point in the overview, it is opportune to return to the e-conference "Auditing the ark – science-based monitoring of biodiversity" which in some way represents the latest in concepts regarding biodiversity monitoring at a European level, even in terms developing appropriate surveying tools.

In fact, during this meeting, apart from highlighting the main challenge in carrying out effective biodiversity

	Alpha diversity	Beta diversity	Gamma diversity
Definition	diversity comprised inside a habitat	diversity comprised inside a mosaic of habitats, including the border effects	diversity comprised inside a biogeographical region or a country
Conditioning factors	• fertilizers • structure • techniques of land use • cultivation management	• heterogeneity • length of the linear elements • dimensions of the units of soil use	• variation of the distribution range • species' appearance • species' extinction
Protection's main strategy	development/optimization of the techniques of land use	• biotope protection • compensation areas • biotope network	• species protection • reintroductions • implementation of wide corridors • possible isolation
Supposed development in the '90s	diminution (except perhaps in the forests and in the settlements)	• increase in the regions of the plains • diminution on the mountains	Increase in Switzerland
Interested species	Abundant and widely distributed species	Widespread but little abundant species	Rare species
Temporal dynamics	moderate	rapid	Slow
Surface reference unit	Land use typology unit	• regions • altitude levels	Biogeografical regions
Principal indicator	Average richness of species variation over small surfaces for land use typology unit	Average richness of groups of species variation chosen for each surface - raster of one square kilometre	Wild species variations in Switzerland

Table 7.8 - The three levels of specific diversity adopted by the Swiss biodiversity monitoring programme (HINTERMANN and WEBER, 1999).

monitoring capable of distinguishing natural variations from those of anthropogenic origin, the most desirable characteristics of monitoring programme were identified:

- practical to use, with methods that are simple, cheap, consistent, robust and reliable;
- development should focus on or include already existing monitoring programmes;
- programmes should include parameters/indicators that provide early warning of irreversible declines;
- programmes should not be limited to particular habitats or features but should include all spatial elements in landscape, capturing the interactions between habitat in the landscape / catchment;
- should provide easily understandable evidence of what is happening, relevant to politicians, scientists, NGOs and the public generally and permitting measurement of progress towards targets and/or decline towards threshold for action;
- should provide information on biodiversity that can be integrated with environmental and socio-economic data.

Moreover, it was argued that a core programme of monitoring should comprise two elements: an extensive network of monitoring using as simple protocols and sampling strategies as possible, and a series of intensively monitored sites to test the methods being used in the extensive network, focus on aspects that an extensive could not afford to cover and to quantify the contribution of natural and anthropogenic influences on biodiversity. The intensively monitored sites would be most effective if placed along land-use intensity gradients and to "target those areas and habitats where pressures are known to be high."

Among the priorities for research put forward in the conference was the development of new methods for biodiversity assessment, for example, modelling approaches to biodiversity assessment (while recognising that monitoring methods have often developed from "nature surveillance").

Last of all, the concluding remarks of the e-conference indicated that "Monitoring is not only about change. It is also about cataloguing the biotic richness in an area, in the sense that it offers the link between the taxonomic investigation and the understanding of the ecological structure – and function - of higher levels of biological organisation."

Another important event was the Silkeborg Confer-

ence (Denmark) held from 4th-6th October 2002 organised by the European Platform for Biodiversity Research Strategy (EPBRS). The EPBRS is a forum of scientists and policy-makers to censure that research contributes to halting the loss of biodiversity by 2010: It supports the European Union and Member States on issues connected to the BioPlatform, the forum that organised the e-conference on Auditing the Ark.

This is evident in the final conclusions and recommendations to the meeting entitled: *Agreement of the Participants of the European Platform for Biodiversity Research Strategy, concerning "Auditing the Ark – Science-based Monitoring of Biodiversity*, which contains a more explicit and structured appeal of the message of the e-conference, and it is articulated in two parts: statements and recommendations.

The following are some of the most interesting statements:

- effective management of ecosystems depends on the monitoring of indicators in the DPSIR framework, which are all important elements of science-based monitoring;
- there is a strong need for research to support science-based and policy-relevant monitoring at different levels (genetic, species, habitat, ecosystem); long-term monitoring programmes should generate scientifically sound, comparable, policy relevant data sets that provide the basis to assess a) the general status and trends in biodiversity, b) the impact of land use, global change, invasive alien species, and other drivers on biodiversity and c) the effectiveness and efficiency of conservation policy;
- science-based monitoring implies that data are collected, processed, analysed, reported and archived according to scientifically-sound methods and protocols that are repeatable within sites
- the importance of strategic coordination between the scientific community and policy-makers;
- local and indigenous people and their knowledge may have a significant role in biodiversity monitoring programmes;
- the need to utilise existing databanks and monitoring programmes.

The following are some of the recommendations made to the scientific community and policy-makers:

- develop a core programme of biodiversity monitoring across Europe in cooperation with relevant EU and national institutions and IWG-Bio-MIN (International Informal Working Group for Biodiversity Monitoring and Indicators, set up by EEA). This includes developing and applying methods to integrate already existing national and regional monitoring schemes into a European monitoring programme, with specific reference to biodiversity relevant environmental legislation;
- develop and assess appropriate scientifically sound and rigorous monitoring methodologies of biodiversity based on standardised protocols and sampling strategies to maximise synergy, integration and interoperability;
- analyse research and information gaps in monitoring programmes and set specific targets to close these gaps;
- encourage and disseminate as part of best practice cooperation among the various monitoring programmes and information network.

It is interesting to note how there is a strict correlation between these conclusions and what is currently emerging at a European level with regards to the approach adopted by the system of agencies with regards to biodiversity monitoring.

The Italian experience

Table 7.9 lists the principal monitoring projects carried out in Italy in an effort to elaborate a national monitoring programme on biodiversity.

The projects briefly described below are quite different from each other, finalised to gather sectoral-information though pooled together with regards to the Italian territory. It could be quite useful in identifying the general situation, in that they refer to monitoring programmes in which sample plots are surveyed on a regular basis according to standardised methodologies.

Though the objectives of these programmes are not explicitly aimed at collecting information on biodiversity, they could be extremely useful in establishing a national monitoring network that avails itself of large national information systems that could provide clear indications to policy-makers and the general public regarding the effects of human development and natural changes on biodiversity.

Instead, none of the large databanks produced from single projects have been illustrated here; however, they could supply background information on which to elaborate national monitoring programmes.

Among the projects set out in Table 7.9, there are several considered extremely useful by the National Topic Centre on Nature and Biodiversity as regards to monitoring biodiversity (APAT, 2002c).

Network name	Network responsible sites	Geographical area	Monitored elements	Objectives of interest	Beginning of activity	Number of sampling
Network of phenological Italian gardens	No single reference	Italy connected to a European network	Selected plant species	Phenological variations of a few plant species with respect to various perturbing factors	Not known	15 phenological gardens
Italian network of allergenes monitoring	Italian Association of Aerobiology (AIA)	Italy	Pollens of species of allergological relevance	Variations in pollen temporal distribution	Not known	100 stations
Data bank for the numerical control of bird fauna	National Institute for Wild Fauna - INFS (activities run by Province offices for wild fauna management)	Italy	Bird species	Bird populations numerical control, informations required by t he Birds Directive (Dir. 79/409/EEC)	1997	Not known
Data bank of the National Ringing Centre	National Institute for Wild Fauna - INFS	Territory comprised within the migration routes of the birds captured in Italy	species and physical characteristics of the ringed birds, distance covered and direction	Control of the migratory species, spatial and temporal variations of migratory behaviours	1939 (re-captures) and 1982 (ringings)	Not known
Ungulates data bank	National Institute for Wild Fauna - INFS	Italy	Ungulates (census, selection and elimination plans)	Sustainability of hunting extraction	1990, though incomplete until 1996	Not known
Integrated national network for forest ecosystems control (CON.ECO.FOR)	General Direction for forest, mountain and water resources, Ministry of Agriculture and Forest Policies	Italy connected to European network	Main forest biocenoses, comprising lichens, fungi, bryophytes, insect fauna, etc…	Forest health through functional and structural variations of the ecosystems with regard to disturbance factors	1995	20
Monitoring network for the protection of the sea Si.Di.Mar., Sistema Difesa Mare	Service for the protection of the sea of the Ministry of the Environment	Italy	Oceanografic, chemical, biological and microbiological data	Coastal and marine environment quality	1996 2001-2004	81
GRUND Research programmes (Gruppo nazionale valutazione risorse demersali)	General Direction for Fishing and Aquaculture, Ministry of Agriculture and Forest Policies; IFREMER, France	Italy and Corsica	Benthonic and demersal species	Biology of demersal resources	Not known	Not known

To be continued on the following page

Research programme MEDITS (Mediterranean International Trawl Survey)	S.I.B.M. (Italian Society of Marine Biology)	Italy connected to European network of Mediterranean countries	Benthonic and demersal species	Biology of demersal resources	1994	Not known
Project AFRODITE	ICRAM	Italy, zone A of the marine reserves	Benthonic populations, fish fauna	Assessment of environment quality	2001	Not known
ALIEN Programme (Atlantic and Lessepsian Immigration Environment Noisness)	ICRAM	Mediterranean area	Oceanografic, chemical, biological data	control of development of Mediterranean 'tropicalization' and relative ecological e genetic impact	Not known	Not known
Network MITO 2000 (Italian Bird Monitoring)	University of Milan, Bicocca	Italy	Bird species	monitoring of bird fauna presence over the entire territory	2000	UTM grids 50 km sided
Monitoring network of superficial water quality	National System of Environment Agencies, CTN/AIM	Italy	Biotic elements of the superficial water bodies' ecosystems (inland, transition, marine waters)	Ecological state deriving from water bodies quality control; they are selected for the relevant environmental interest or for the significant pollution drive	2001	Not known

Table 7.9 - Examples of monitoring programmes concerning biodiversity at the national level (APAT, 2002c). *Following from previous page*

The Italian Aeroallergen Network with centres throughout the country was created by the Italian Association of Agrobiology (*AIA*). It publishes weekly pollen bulletins that provide information about the levels of the main allergenic pollen types.

The National Programme for Monitoring Forest Ecosystems (CONECOFOR) set up by the Department for Forest, Mountain and Water Resources of the Ministry for Agriculture, was launched within the European IPC Forests Programme. It utilises the IPC Forests' standard methodologies and the sample plots identified for Level II forest surveying, though it adds further data on bioindicators (lichens, fungi, bryophytes) and studies on biocenoses (insect fauna, plant phenology, etc.).

The choice of areas to survey regards to the ICP Forests programme has already been made on the following criteria. Each sample plot must be:

- representative of the principal forest species and the main conditions for growth in the country,
- minimum 0.25 hectares in size,
- situated in buffer zones,
- far from local sources of pollution,
- suited for long-term monitoring,
- easy to reach and sample,
- homogeneous as possible to the buffer zone in which they are situated as regards to anthropogenic management, tree species, species variety, age, size of tree population, soil type and gradient,
- have a sufficient number of trees per plot for the programmed survey.

This is an interesting example of coordination between regional and provincial government authorities and research centres that have united forces in carrying out a joint programme that is important from a scientific point of view.

Apart from the databank of the Italian Ringing Scheme (*Centro Nazionale di Inanellamento Italiano)* connected to the European *Euring,* the National Institute for Wild Fauna (INFS) manages other fauna monitoring projects, such as the Ungulates Databank used to evaluate sustainable hunting activity. The databank is a collection of information on surveys, plans and regulations regarding the hunting and capture of ungulates in Italy.

With reference to water protection measures adopted according to Legislative Decree 152/1999 amended by Legislative Decree258/2000), APAT is elaborating a network to control water resources which provides for the monitoring and classification of water on the basis of environmental quality objectives. For information on the qualitative state of water bodies, it relies on a nation information system on environmental monitoring made up of thousands of monitoring stations on the water cycle (hydro-meteo-pluvio parameters). Chemical and ecological analyses are carried out; and apart from the Extended Biotic Index (EBI) based on macroinvertebrates to assess water quality, an evaluation of the biological and morphological elements of coastal, transition and lake habitats is also made.

At a regional level, systematic and regular monitoring activity by public authorities has not been carried out over time to gather information on biodiversity. In any case, several initiatives of an experimental nature have been conducted, which are propedeutic to the planning of routine activities.

An example is the project that ended in 2000 for the mapping, monitoring and management biodiversity in Lombardy, carried out on an experimental basis in several protected areas by the *Fondazione Lombardia per l'Ambiente* (Lombardia Foundation for the Environment).

A more articulated project was the assessment and monitoring of Sites of Community Importance set up in Piemonte in 2002 by the regional environment agency; a regional project which is considered one of the first steps towards the creation of network which could be extended to the entire national territory, in compliance with Council Directive 92/43/EEC (Habitats Directive) and the DPR. 357/97 in application of this aforesaid Directive.

Nine sites were studied in the first phase of the project, chosen on the basis of criteria of sensitivity and direct pressures in the area; after which the project was extended to a further 30 sites which totals about 20% of Skis cover of the Region. Apart from the survey conducted on the initial environmental conditions, the sources of direct pressure, environmental quality and the impacts were highlighted. This work led to an assessment of the anthropogenic load, environmental quality and relative trends, level of naturalness of the biotopes and their sensitivity to deterioration.

It is clear how in this case, attention was focused on identifying the critical elements that directly influence the site and not the large-scale processes on a national and European scale, which instead occurred in the case of the previously described networks.

The Toscana Region is also preparing a series of initiatives to support a regional programme on monitoring biodiversity in the next future.

The first of these will be the *Repertorio Naturalistico Toscano,* a databank which will form the information basis for monitoring activities.

Then there are other activities regarding biodiversity protection in the context of the Natura Life Project, which in particular, regard the Island of Capraia and the minor islands of the Tuscan Archipelago with monitoring projects on the habitat, flora and the bird colonies of particular interest (for example the Audouin's Gull - *Larus audouinii* (Payraudeau, 1826), as well as monitoring the Yellow-legged Gull in all the archipelago. Monitoring projects on the woods and pastures in the Apennine area are also about to commence.

ITALIAN INITIATIVES MANAGED BY THE SYSTEM OF AGENCIES

As already mentioned, the concept of a monitoring network applied to biodiversity is less intuitive and conventional than other environmental aspects, though this is essentially due to the fact that is has only recently been introduced.

In reality, it is possible to carry out monitoring techniques and set up specific networks for all environmental aspects, once the most significant indicators have been identified. Therefore, in order to set up a monitoring network, these indicators need to be surveyed periodically and measured at fixed points in the territory.

The problem faced by the national Environmental Agency System was to define the appropriate set of indicators that reflect trends in the state of the environment, that supply information on environmental problems, which support policy development and priority setting, and that monitor the effects of policy responses.

The methodological framework utilised by the national Environmental Agency System is the DPSIR model, as it is useful in describing the relationships between the origins and consequences of environmental problems. It is coherent and useful tool with environmental reporting at a supranational level, and it provides information about phenomena that are regarded typical and/or critical to environmental quality for policy-makers and for the general public alike.

For this reason a study (Figure 7.10) was conducted to identify the core set of indicators, divided into the five categories of the DPSIR model. The study led to the identification of the various typologies of biodiversity indicators (Figure 7.11).

Naturally, this only represents one component of the methodological framework, which has the great merit of being coherent with the corresponding approach utilised at a European level and with the subsequent stages of data utilisation.

The work programme that has been operative since the early 1990s by the Environmental Agency System to develop a monitoring network even in the sector of nature conservation.

Among the initiatives in the following section, there are several in which the national Environmental system participated, such as the European Environment Agency's pilot studies of the different biogeographical regions in Europe.

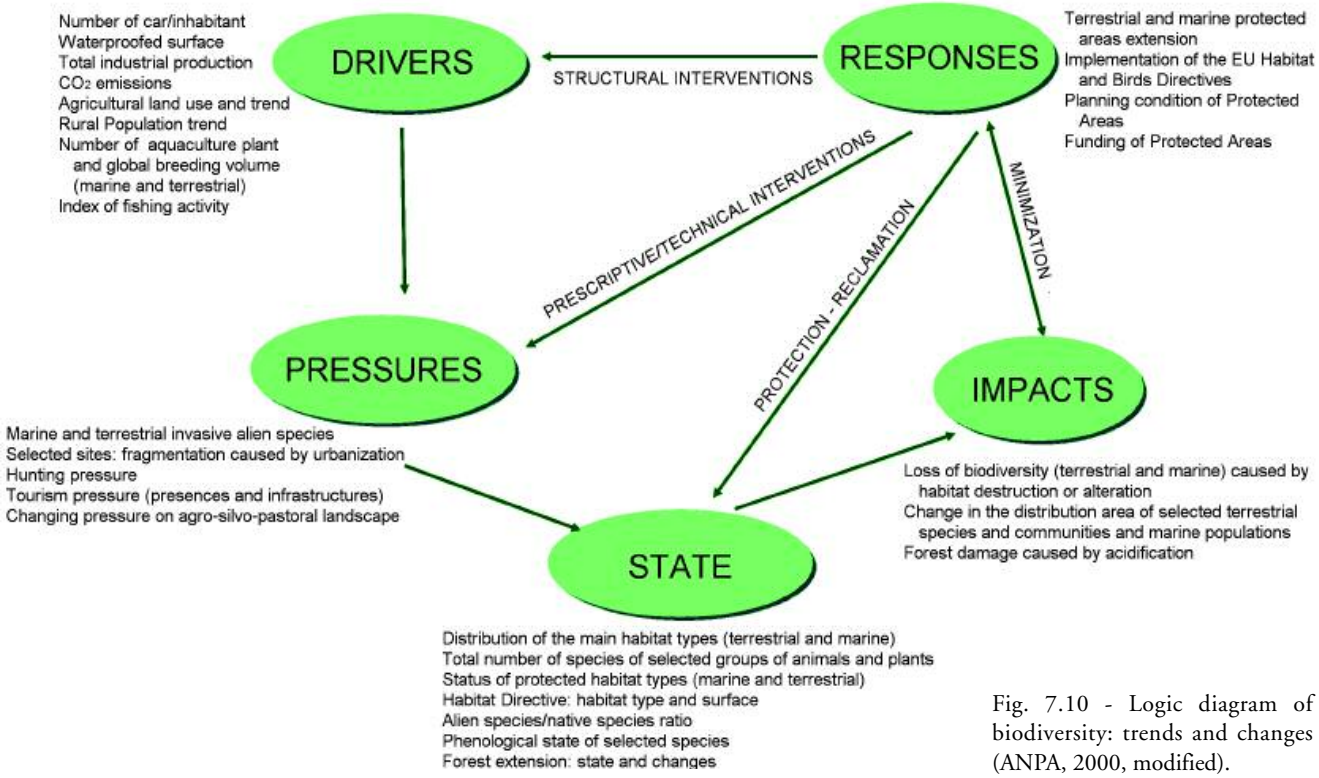

Fig. 7.10 - Logic diagram of biodiversity: trends and changes (ANPA, 2000, modified).

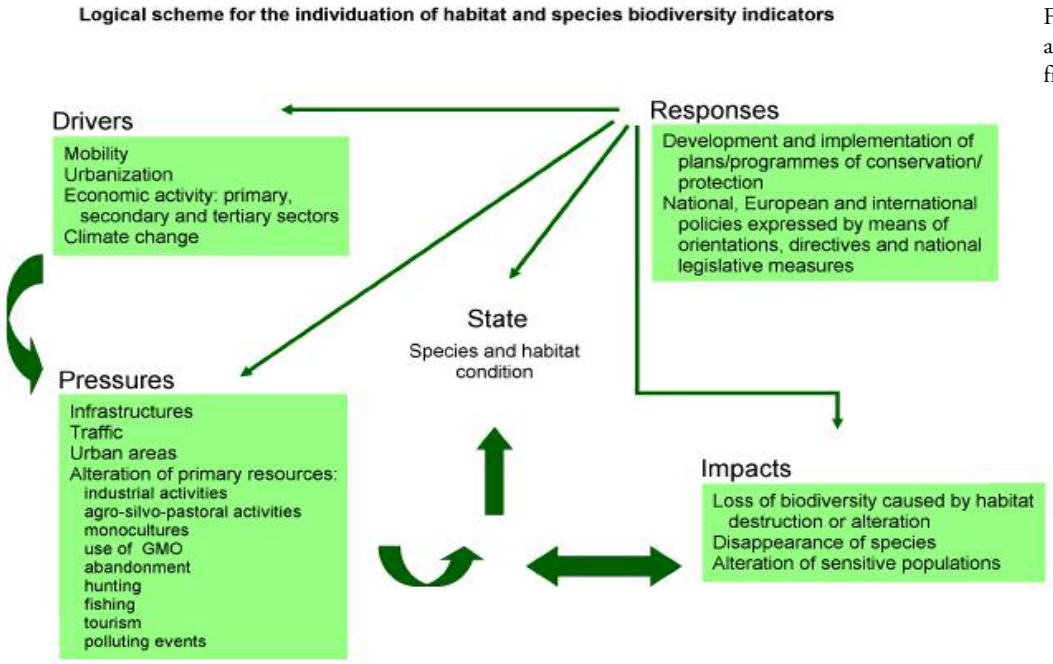

Fig. 7.11 - Indicators arranged according to the DPSIR framework (ANPA, 2000).

The Pilot Study of the Alpine Biogeographical Area

The Pilot Study (ANPA, 1997) assigned by the European Agency to Italy, regarded the Alpine biogeographical region (which comprises the Community territory of the Alps, the Pyrenees, the Apennine mountains, and the northern Fennoscandian mountains) was conducted by ANPA in the spring of 1996.

The University of Rome *La Sapienza,* through the Botanic Gardens which coordinated the project, and the University of Calabria participated in this study.

The first stage consisted in selecting the area based on specific requisites furnished by the European Agency with particular reference:

- ecological regions identified in the Digitized Map of European Ecological Regions (DMEER),
- availability of CORINE land cover data,
- availability of qualitative-quantitative data on species, habitats, land use, and trends,
- characterize the biogeographical region, both in terms of size and characteristics,
- possess designated protected areas at either a national or an international level.

On this basis, an area of 150,000 hectares was selected in the southern region of the Bellunese Dolomites, where the following are present:

- areas of high naturalness (Bellunese Dolomites National Park in the south; Paneveggio-Pale Nature Park of the Autonomous Province of Trento in the north),
- anthropogenic settlements in the plains (the areas of Feltre and Belluno),
- mountain area the scarce presence of man.

With regards to land cover, information was provided by the *Istituto Nazionale di Economia Agraria* while the digital mapping was provided by ISTAT, utilising the ISTAT and CORINE land cover classes.

With reference to information on habitats, flora and vegetation, a great deal of data came from literature, unpublished phytosociological surveys produced previously by participants in the study, photo interpretation of IGM aerial photos (flight 1972) and field surveys conducted during the study.

Information on national legislation was obtained by consulting the lists of protected Italian Flora at a regional level, while as for protected species at an international level, the lists of the Habitats Directive Annex II and IV were used.

The risk categories (IUCN) were taken from the Red List of Italian Plants and from legislative references.

Greater difficulty was encountered in finding data relative to fauna, especially with regards to mammals. Reference was made to atlases and catalogues of the specific area and to direct observation in the field.

As far as birds were concerned, it was not possible to identify the protected species at a European Community level.

Endemic species for both invertebrate and vertebrate fauna were not ascertained.

In the second stage of the project, biodiversity values were assigned according to criteria established at a European level (naturalness, ecological quality and threat, presence of species of special ecological and landscape value). While as far as ecological quality and threat are concerned, reference was made to the following six parameters, selected among those by proposed by the European Agency: maturity, macroclimate, pasture cover, stability of mountain slopes, land cover, water table levels.

The following parameters were taken into consideration to evaluate the species of particular importance: threatened species, species richness, and decline of common species.

Only one landscape unit was considered in this study: the external Dolomites in which five subunits were identified:

- large valleys
- erosive valleys
- hills (<600 m)
- mounts (without perpetual snow, 600-2000 m)
- high mounts (with perpetual snow or glaciers, >2000 m),

And the following five assessment parameters were used; heterogeneity, possibility for recreational use, scenic value, naturalness, anthropogenic presence

According to the authors of the study, even though it was not possible to draw definitive conclusions, given that the study itself was only the first step in evaluating the status of biodiversity, important indications were obtained about the general methodology to utilise for the Italian Alps.

Moreover, the methodological approach, such as the classification of habitats according to Northern European logic was not appropriate to the high levels of biodiversity present in the Mediterranean region, which highlighted the necessity and urgency to develop a standardised monitoring methodology at a national level, coherent with that of other European countries, which in some cases was already operative.

The Agency project on the biodiversity monitoring network

In 2001, APAT (then known as ANPA) set up a preliminary project to prepare the framework for a biodiversity monitoring network, through the National Topic Centre (*CTN-CON*, now known as *CTN-NEB*).

This project firstly set up of a multidisciplinary working group which discussed various aspects of methodology and identified a general outline for a possible network, and secondly, four case studies promoted by ARPA participants were evaluated with the support of the *Istituzioni Principali di Riferimento* (*IPR*) connected to the CTN-CON to verify the feasibility of several project proposals and to delineate hypothetical problems that could arise from future monitoring programmes.

The necessity for a monitoring system originated from the need to collect information of fundamental importance to study the status and trends of ecological systems that was lacking in existing databanks. This information was considered indispensable for the set of indicators prepared by the Agency system (APAT-ARPA-APPA) through the CTN-CON Project in order to define the framework of environmental conditions linked to nature conservation. This idea of a biodiversity monitoring network would, in fact, be of operative support to policies on nature conservation and the quality of the territory.

A network elaborated specifically with the aim of environmental reporting and managed by the national System of Environmental Agencies would, in fact, ensure the temporal continuity in data collection and uniformity in the methodological approach. The Agency has conceived the programme in the context of cooperation and collaboration with similar Italian and European biodiversity monitoring initiatives connected to the European monitoring programme which the European Environment Agency has recently inserted (2001) its operative plans of the ETC/NPB.

The working group has defined the objectives and identified the users, the network structure, the elements to monitor, and the methods for data collection. Instead, crucial issues tied to statistical aspects in the defining the sampling and in elaborating data or in evaluating data and elaborating indicators were deferred to subsequent times.

The report drawn by the working group (APAT, 2002b) first identified which knowledge gaps still had to be filled regarding the biological stock., and evaluated the critical aspects in order to prepare a solid basis to create models of the processes underway.

Moreover, complex elements such as temporal variations of groups of species, the critical processes involving threatened species, the use of biological diversity as an indicator of problematic processes were also examined .

The proposal to set up the monitoring network makes reference to report as comprehensively as possible on the many facets of biodiversity (various levels of species diversity, habitats and landscapes biodiversity), specifying that the emphasis of species diversity regards their con-

sistency rather than the number of species present. If the approach to species diversity is present also in other monitoring networks, such as the Swiss one, the addition of landscape diversity is very innovative considered in terms of "temporal change of similar land use types, sampled in the same area in different periods." Landscape thus becomes an essential element for ecological stability and takes on the twofold role as a context in which the dynamics tied to species and habitats react, and the instrument by which management policies can be assessed.

This position leads one to adopt a "territorial" point of view which consists in "identifying the most important territorial phenomenon that one considers could influence, or in any case, is connected to the dynamics of biodiversity, and the most appropriate means to monitor them." Therefore, both the variables of biodiversity and those variables that characterise the territorial processes (*driving forces*) should be monitored as they affect changes to biodiversity itself. The tool through which this twofold control can be carried out is based on applying the indicators set out in the DPSIR framwork.

The criteria used in selecting which habitat types to monitor, the number of *taxa*, the quantification and the identification of sample sites is based on the knowledge and control of critical environmental elements: monitoring would serve to gather useful information on each of these critical elements that affect biodiversity in the country.

The critical elements identified by the working group are listed in Table 7.10, on the basis of the causal chain approach of the DPSIR framework.

These critical elements do not affect all types of ecosystems throughout the entire national territory to the same extent. Hence, a proposal was put forward to connect the critical elements to the contexts where they most influence the changes to the status of local habitats, and in particular to biodiversity.

In fact, to limit the monitoring activities to programme to a selection of species and *taxa*, habitats and ecosystems, the use of dominant critical elements criteria in specific ecoregions would seem to be the most effective method, and in line with the general objectives outlined previously. In this sense, the choice of sample areas used to evaluate the critical elements, and upon which the monitoring network is based, falls within the subdivision of the territory proposed in recent studies by the Ministry for the Environment Land and Sea Protection on the APE Project and of the national system of protected areas.

To define the network, the territory is thus divided:

1) Alps (Eastern and Western, according to the Alpine Convention scheme)
2) Padano-Veneto Plain,
3) Apennines and peninsular territories, divided into:

The Apennines mountains, (divided into northern, central, southern Apennine regions), Calabrian-Sicilian, Tyrrhenian, Adriatic, Adriatic ionic belts between the coastline and the Apennines,

4) Islands: Sicilia, Sardegna, minor islands,
5) Coastal belt.

The identification of the temporal and spatial dimensions of this project was a complex task. An initial period of 5-10 years was indicated as the necessary time period to carry out monitoring procedures in order to ensure a correct evaluation of the many factors involved in the process. However, the choice of the representative element was to be made on a case-by-case basis, not only on the basis of the cognitive objectives, but also in lieu of the single species present, above all animal species, and the ecomosaic in question.

According to the APAT network model, the aspects to monitor could be selected on the basis of their importance in the revealing the dynamics underlying the critical elements described above and referred to the following categories of variables:

- particular species of great importance (various endemic species, etc.);
- important taxocenoses (birdlife, nematodes, lichens, etc.);
- typical communities (fluvial macrobenthos, phytocenoses, etc.);
- typical habitats, (beech trees woods, resurgences, etc.);
- landscape elements;
- important ecomosaics;
- ecoregions.

The data collection would involve information gathered from field surveys along with information from existing databanks of other monitoring programmes that could be usefully employed for this specific network. Such a wide-ranging monitoring programme implies the involvement of the great many subjects directly interested in utilising the results or in providing their own skills. In particular, the working group stressed the need to involve and coordinate the efforts made by the Ministry for the Environment Land and Sea Protection and the APAT, the environmental agency system, research centres, NGOs, and interested private actors.

The proposal of a monitoring network also accounts for several aspects that regard the choice of *taxa* and the types of habitat.

Critical processes tied to driving forces	• climatic changes (eg. from pressures exerted at the global level) • depopulation processes, abandonment and productive delocalization • improper urbanization processes (illegal or not), urban expansion, settling dispersion • changes in the consumption and mobility models • development of tourism • industrialization and 'modernization' of agriculture and silvicultural activities • unsustainable technological developments (real or potential) • pervasive diffusion of infrastructural grids • distorsions in the flows of materials and wastes • spatial redistribution of the settlements and of the anthropogenic activities • mountain and rural exodus • weakening or disappearance of protection and maintenance activities over the territory
Critical processes defined by pressure factors	• pollution of base environmental matrices (air, water, soil, acoustic and daylight environment) • 'engineering forcing' carried against the territory (excessive artificialisation of water networks, etc.) • traffic increase, mobility deterioration • air, soil and water pollution, acoustic and light pollution, 'waste emergency' • spreading of incidental risks, detrimental genetic pollution, etc. • reforestation and regression to the wild of agricultural and pastural landscape • fragmentation of ecological matrices • significant hunting pressure • non sustainable fishing pressure • creation of diffusion conditions of alien organisms or of GMO
Critical processes defined by impacts on sensitive environment matrices	• glacier surface and volume reduction • desertification in arid and semi-arid environments • water cycle alterations • sea water level increase • alluvion risk increase • intensification of erosion processes, landslides and unbalances, hydrogeological and hydraulic risks • hydrogeological destabilization, disappearance of the terraces and of forestry structures, forest management suspension • ebbing of wetlands, littoral zones and other habitats of great value • long distance atmospheric pollution (especially rain acidification) • eutrophication of marine and lake environments • weakening and impoverishment of the diffuse settlement heritage and of the related rural landscapes • energetic wastes and non sustainable consumption of spare resources (water resources, high capacity soils, valuable forest formations and old woods, etc.) • landscape diversity loss, erosion of ruaral matrices and of agricultural landscapes (above all the 'little scale' ones) • landscape uniformation and over simplification • disturbances' increase on sensitive species and environments • increase of vulnerability to critical events (eg. fires)
Critical processes defined by impacts specifically connected to biodiversity status in the strict sense	• rarefaction and extinction risks for critical species (animal and/or plant) • loss of potential biodiversity values in not sufficiently studied environments • artificialisation and simplification of ecosystems' systems (ecomosaics, ecotextures) at the regional or sub-regional level • connectivity and ecological permeability losses in valuable ecomosaics • alterations of biotic communities in relatively intact ecosystems

Table 7.10 - Environmental and territorial critical elements conditioning biodiversity (APAT, 2002b)

Having established that monitoring is to be limited to *taxa* that are "relevant and/or important (though not indicators) with respect to a particular objective", then for the criteria used their identification should be based these *taxa* being characteristic of the territory, of ecological interest, and feasible to survey in terms of cost and organisation.

The proposal indicates that first of all the types of habitats or habitats mosaics to monitor should be chosen and then establish the *taxa* groups to consider. Excluded from this type of selection are the endemic or threatened species that should instead be monitored in a thorough manner with a complementary surveying system.

Moreover, data regarding the presence/absence of groups of species from existing databanks is considered necessary in creating a "network of networks."

As regards to the ecomosaics, three main survey typologies are indicated: the transect made across vast areas to verify the great environmental changes that occurred over time, the identification of ecomosaics that represent the problems found in large territorial units, and the identification of certain areas where the ecomosaic can be analysed on the basis of the precise needs are linked more to specificity of the region than to its critical elements.

In conclusion, the useful attributes to describe the sites to monitor, can be summed up as follows:

- sampling unit, understood as the minimum area to explore in order to gather important information regarding the object surveyed;
- the time frequency of the survey can be on either a regular basis, annual, or variable depending on each case;
- the method of collecting data, which describes the most opportune technique to use depending on the object to monitor, the sample unit, and the general criteria of low cost that guarantees continuity and the feasibility of the monitoring programme itself;
- the presence of important elements to monitor (such as endemic, rare or threatened species, etc.);
- the minimum number of sampling units need to be observed in order to identify reliable trends for certain area types;
- the indicators connected to soil analyses as in Table 7.11;
- the presence of experts for specific monitoring activities;
- the role of ARPA, considering that the logistic and general organisational aspects must always, and in any case, be the responsibility of the agencies.

Among the indicators listed in Table 7.11, there are some that refer to physical parameters and not biological ones, as these parameters are very useful in evaluating the effects of climate change.

Terrestrial and marine species that have become invasive	P
General number of plant and animal species	S
Condition and trend of a few selected plant and animal species or groups of species (terrestrial and marine)	S
Status of protected habitats typologies (terrestrial and marine)	S
Biodiversity loss (terrestrial and marine) through habitat destruction or alteration	I
Biodiversity loss (terrestrial and marine) for selected plant and animal species	I
Glacier mass balance	S
Marine level of coastal areas	S
Variations of glacier fronts	S
Phenological status of a few selected species	S
Distribution range variation of species and selected marine and terrestrial communities	I
Landscape diversity loss	I
River landscape assessment on the basis of the Index of River Quality	S
Increase in desertified areas	I

Table 7.11 - Indicators to be populated with the data gathered by agency-proposed biodiversity monitoring project (APAT, 2002b).

The project regarding the biodiversity monitoring network – Case Studies

The Agency system has carried several case studies for the project of the biodiversity monitoring network to examine the most problematic management aspects tied to setting up sampling sites for of a supposed network (Table 7.12). The definition of the sampling grid, as well as all aspects linked to the elaboration of data based on set indicators were identified by the CTN in a period prior to the set up of the working group which outlines the proposal for the network described above, and hence they make reference to very general needs and should be integrated with others which better suit the chosen methodological approach in monitoring changes to biodiversity in the different ecoregions of the national territory.

These case studies were conducted by several ARPA agencies with the support of the IPR participants in the CTN-CON. The work was carried out in a very short time and with a methodological framework of the monitoring scheme still in its preliminary stage. The main objectives were to evaluate the operative and logistic problems, define the cost and time of the surveys, and identify the necessary skills to organise the work, in particular, those that the ARPA personnel were expected to carry out, regardless of the contribution given by experts. Parallel to this, at an even more preliminary level, several methodological

aspects regarding the choice of the elements to survey and the method of data collection were evaluated.

In reference to developments in the general methodological proposal, the sites were identified on the basis of certain ecoregions that were considered the primary territorial units in structuring the monitoring network. Sampling sites which were most representative of the critical elements present in the national territory were then chosen within each of these ecoregions. Subsequently, the ecomosaics which were most affected by these critical elements were then identified, and within these, a selection was made of the species, habitats, and landscapes to survey. The critical elements are indicated by the framework elaborated by the working group to define the methodological approach of the monitoring network, which connects these elements to the ecoregions by identifying the most important ones for each primary territorial unit (Table 7.13). In this phase, the statistical approach was taken into consideration, given the organisational aims of the study.

The case studies were located in the following areas:

- Capanne di Marcarolo (Alessandria), a hilly area of chestnut tress that represents the Apennine montane ecoregion;
- Massaciuccoli Lake, a site made up of a coastal lake surrounding wetlands which represents the coastal ecoregion;
- Several sites in the Maratea area which represent coastal areas and the Mediterranean marquis.

Parallel to this experience that directly involved the ARPA agencies, two studies were conducted methodological approaches for monitoring land environments and coastal environments by the main research centres that support the CTN. As regards to coastal-marine environments, a great of information was provided by recent studies on the Tremiti Islands and the Castelporziano Oasis.

The first three case studies, in particular, were conducted by ARPA with a uniform methodology, the sharing of a reference glossary, the compiling of a technical file (Table 7.14). Hence, for all the sites in question, the following were identified: Important elements, the principal critical elements, the objects to monitor, and the methods to collect data.

The first three case studies were conducted by ARPA utilising the same methodology, reference glossaries and compilation of technical profiles (Table 7.14). The following were identified for all sites: factors of great value, the principal critical elements, the aspects to monitor, and the method to adopt for data collection.

For example, in the case study on Capanne di Marcarolo, the abandonment of the agro-silvo-pastoral system was the critical element monitored, as it was considered the fundamental transformation process of the Apennine montane ecoregion in which the site is located. The APAT 24/2002 Report describes this critical element as being connected to the spatial redistribution of human settlements and activities, to the abandonment from mountain and rural areas, to the gradually disappearance of conservation and maintenance activities of the territory. The elements to survey and monitor are several rare species, in eight taxocenoses described for all types of habitats or groups of animal species (nocturnal butterflies, phytophagous entomocenosis, etc.), an ecomosaic (woods, pasture, shrubland), rural landscape elements (isolated nuclei, linear landscape structures, specific elements). A surveying method was defined for each typology which included the comparison between present and past status on the basis of aerial photos or historic cartography, the phytosociological survey of vascular plants, the gathering of the most appropriate methods for endofauna (for example, artificial light and cloth sheet or sweep net), the creation of transects for ecomosaics.

In an attempt to define the minimum number of sites to monitor in order to identify reliable trends for specific ecoregions and of the categories of critical elements taken into consideration, and to define the surveying frequency of various elements was of great interest. Last of all, the role of ARPA and its technical-scientific, organisational and coordinating role, the experts needed for the project, and the specialist aspects to study were identified.

A particular experience conducted analogous to the previous case studies was the planning of a monitoring project to gather information on the effects of climate change on natural systems. Monitoring climate change, given its multidisciplinary character and the complexity of temporal developments, is more suited to be carried out within a network of networks system, partially utilising those already set up and partly a defining specific one, thus exploiting the synergy created to the most.

For this reason, studies regarding the mass balance of Alpine glaciers and the surveys on variations to high attitude vegetation have taken place through participation in the international GLORIA Project coordinated by the University of Vienna. Moreover, feasibility studies were conducted for a monitoring networks regarding permafrost, the phenology of several cultivated and spontaneous plan species, and the chorology of groups of Lepidopterans and Odonates.

CRITICAL ELEMENTS ECOREGIONS	a1	a2	a3	a4	b1	b2	b3	b4	b5	b6	c1	c2	c3
1. Alps	X		\		\	X		\		\	\	\	\
2. Padano-veneta plain			X	\	X	X	\	\	X	X			
3.1 Montane Appennine						\			\		X	\	\
3.2 Preapennine belts			\			\	\	\	X	\			
4.1 Sicilia		X		\	\					\			\
4.2 Sardegna		X		\	\	\							\
4.3 Minor islands		\			X			X					\
5. Coasts				\	X	\	\	X		X			

X emerging critical element in each habitat,
\ habitat secondary critical element

CRITICAL ELEMENTS TO BE MONITORED AT THE NATIONAL LEVEL

Critical elements connected to the *global change*, such as:

a1) glacier fusion and similar effects of climate changes,

a2) desertification,

a3) water cycle alteration, increase in the sea levels and high water marks etc.,

a4) long distance pollutions, atmospheric acidification etc.

Critical elements connected to the intensification and diffusion of anthropogenic pressures, such as:

b1) destruction, degradation and mutilation of wetlands, coastal marine areas and other valuable habitats due to urban expansion and to the development of mobility and tourism,

b2) intensification of erosion processes, landslides and unbalances, hydrogeological and hydraulic risks due to improper urbanization processes (illegal or not), to 'engineering forcing' carried out against the territory, to the excessive artificialisation of water networks,

b3) energetic wastes and non sustainable consumption of spare resources (water resources, high capacity soils, valuable forest formations and old woods, etc.), due to settling dispersion, to changes in the consumption and mobility models and to the development of tourism,

b4) pollution of base environmental matrices (air, water, soil, acoustic and daylight environment), 'waste emergency', spreading of incidental risks, detrimental genetic pollution, etc., due to traffic increase, urbanisation and unsustainable technological developments,

b5) landscape diversity loss, erosion of rural matrices and of agricultural landscapes (above all the 'little scale' ones), landscape uniformation and over simplification due to industrialization and 'modernization' of agriculture and silvicultural activities,

b6) fragmentation of ecological matrices due to urban expansion, to the pervasive diffusion of infrastructural grids, to the development of mobility and tourism.

Critical elements connected to the spatial redistribution of the settlements and of the anthropogenic activities, to mountain and rural exodus, to the weakening or disappearance of protection and maintenance activities over the territory, etc.:

c1) loss of agricultural and pastural landscapes, reforestation and regression to the wild due to depopulation processes, abandonment and productive delocalization,

c2) hydrogeological destabilization, disappearance of the terraces and of forestry structures, forest management suspension, etc., due to the above mentioned processes,

c3) weakening and impoverishment of the diffuse settlement heritage and of the related rural landscapes, due to the above mentioned processes.

Table 7.12 - Relation matrix between ecoregions and critical elements of national interest (from APAT, 2002b).

Type	Object	Territory reference unit	Survey method
Single species	Indicator plant species particularly sensitive to saltiness, to be identified	Borders of the protected area or of the wetland	Field survey, to detect the presence /absence of the species
Taxocenosis	Phytocenosis of the cane field	Borders of the protected area or of the wetland	Historical variations (Flight GAI-most recent flight available) of the surface of the cane field evaluated on the basis of the aerial photographs
Taxocenosis	Phytocenosis of the sphagnum field	Borders of the protected area or of the wetland	Historical variations (Flight GAI-most recent flight available) of the surface of the sphagnum field evaluated on the basis of the aerial photographs
Taxocenosis	Phytocenosis of the emergent hydrophytes field (valuable phytotaxocenosis)	Borders of the protected area or of the wetland	Historical variations (Flight GAI) of the surface of the emergent hydrophytes field evaluated on the basis of the aerial photographs (to be verified)
Taxocenosis	Orchidaceae	Borders of the protected area or of the wetland	Field survey, to detect the presence / absence of the most significant species
Taxocenosis	Nocturnal lepidopterans	Central area of the site Capture by means of artificial light and towel	Taxonomic determination
Taxocenosis	Benthonic macrofauna	Representative sections of water bodies inside the park borders	Investigation (presence/absence) of identified species through taxonomic study of systematic units usually considered for the IBE method
Taxocenosis	Epigeous invertebrate fauna	At least 5 selected habitats	Capture by means of live traps with vinegar solution and taxonomic determination at the various systematic ranks
Taxocenosis	Phytophagous entomocenosis	Surveys on meadows and shrubby areas	Collection through mowing and taxonomic determination at the various systematic ranks
Taxocenosis	Amphibians	Borders of the study area	Taxonomic determination and comparisons between late and current species inventaries
Taxocenosis	Bird fauna	Borders of the study area	Taxonomic determination and comparisons between late and current species inventaries
Taxocenosis	Fish fauna	Lake, canals, small water bodies	Taxonomic determination and comparisons between late and current species inventaries (data contained in the fish maps and other past collections) and evaluation of population structure variations
Habitat	Varied habitats on the basis of the critical elements examined	Borders of the study area	Calculation of plant surfaces variation to describe the evolution of abandonment (shrubs pushing through in a meadow, forest advancement and abandonment in general). Comparison between 1954 GAI flight and more recent aerial photographs and implementation of a map of the variations (GIS). Once identified, definition of the habitats present in the changed areas through rapid investigation and reference to the EUNIS list
Ecomosaic	Ecosystemic units that pinpoint relations between the wetland and the cultivated country level	Borders of the study area	Calculation of ecomosaic variation as a spectrum of ecosystemic units' categories comprised between the wetland and the cultivated country level, through a series of transepts from the aerial photographs
Physical variable 1	Water saltiness	At least 3 surface points, possible repetitions where previous analyses have been conducted	Following normally used analyses protocols

Table 7.13 - Massaciuccoli lake, site assessment record, territory reference unit and survey method (APAT, 2002b).

General framing of the site on the basis of available informations	• administrative, geographical, climatic, demographical characteristics, and socio-economical aspects, physical characters and land use, natural conditions, presence of completely or partially included protected areas, detractor elements
Critical elements to be considered for the selection of the elements to be monitored inside the ecoregion	• Connected to the global change (A1, A2) • Connected to the intensification and diffusion of the anthropogenic pressures (B1-:- B6) • Connected to the spatial redistribution of the settlements and anthropic activities, to the mountain and rural exodus, to the weakening or disappearance of protection and maintenance activities over the territory (C1, C2, C3)
Valuable elements to be monitored	• Endemisms, rare or endangered species, etc.
Object of the monitoring activity	• Species, taxicenosis, ecomosaic, landscape components, possible physical variables of interest
For each monitored element:	• Reference to the territorial unit and survey method • Minimum number of surveys in the selected area and their temporal frequency (continuous, annual, pluriannual, variable)
Reference indicators	• Connectes indicators among those belonging to a given group • Further identified indicators
Management aspects	• Expert resources outside of ARPA needed to complete the monitoring • ARPA role • Time, material and resources needed to perform the surveys

Table 7.14 - Record of case studies for the definition of the actions for the collection of information in the sampling area.

The monitoring model put forward by the CTN project is based on the assumption that, apart from the data collection procedures necessary to highlight important elements and critical processes in a given sampling site, all possible sources of data must be used: from data collected directly in the field, information from past and existing monitoring databanks should be considered. The aim is to establish an interactive system, which would outline a general structure for monitoring networks, in such a way as to optimise time and costs, to the benefit of all. The methodological complexity and the need for in-depth knowledge in very different fields and aspects could not be encompassed into a single structure which would contain all the information that is indispensable for an articulated monitoring network such as that of biodiversity. Moreover, together with the collaboration of different networks of data collection, there is a need to create a tighter system of collaboration and highly specialised consultation.

The experiences described up to this point are of an experimental, explorative nature, aimed at obtaining the necessary information to organise a future monitoring network whose mission would be to investigate biodiversity conditions through a system of data collection organised either by direct sampling as well as through information collected for other motives. The main criteria to keep in mind are the emergent critical processes underway within each ecoregion, independent of the existing conservation measures.

Bibliography

ANPA, 1997 – *Studio Pilota nella Regione Biogeografica Alpina*. RTI 1/97 AMB-COBI, Roma.

ANPA, 1998a – *Il Sistema nazionale dei controlli in campo ambientale. Requisiti e criteri di realizzazione*. Serie Documenti 2/98, Roma.

ANPA, 1998b – *Il Sistema nazionale di osservazione e informazione in campo ambientale. Requisiti e criteri di realizzazione*. Serie Documenti 3/98, Roma.

APAT, 2002a – *Annuario dei dati ambientali – Edizione 2002*. Serie Stato dell'ambiente 7/2002, Roma.

APAT, 2002b – *Introduzione al progetto della rete di monitoraggio per la biodiversità e gli effetti dei cambiamenti climatici*. Rapporti 24/2002, Roma.

APAT, 2002c – *La valutazione dei dati e delle reti di monitoraggio ambientali*. Rapporti 27/2002, Roma

BURGA C.A., KRATOCHWIL A., 2001 – *Biomonitoring: general and applied aspects on regional and global scales*. Kluwer Academic Publishers, Dordecht.

DELBAERE B., 2002 – *Biodiversity Indicators and Monitoring: moving towards implementation*. ECNC, Tilburg.

EC UNECE, 2002 – *Intensive Monitoring fo Forest Ecosystems in Europe: 2002 Tecnical Report*, Brussels e Ginevra. <http://www.digischool.nl/contents/fimci –tr2002.pdf>.

ETC/NPB, 2002 – *An Inventory of European Site-based Biodiversity Monitoring Networks*. Project report by B. Delbaere (ECNC). European Topic Centre for Nature Conservation, Paris.

EC, 1998a – *First report on the implementation of the Convention on Biological Diversity by the European Community*. Office for Official Publications of the European Communities, Luxemburg. <http://europa.eu.int/comm/development/sector/environment/env_theme/biodiversity/ec_policy/txt05.pdf>.

EC, 1998b – *Communication of the European commission to the Council and to the Parliament on a European Community Biodiversity Strategy*. Brussels. <http://europa.eu.int/comm/environment/docum/9842en.pdf>.

EC, 2001 – *Biodiversity Action Plans in the areas of Conservation of Natural Resources, Agricolture, Fisheries, and Development and Economic Cooperation*. Commission of the European Communitie, Brussels. <http://biodiversitychm.eea.eu.int/conventionn/cbd_ec/strategy/BAP_html>.

EPBRS, 2002 – *Agreement of the participants of the European platform for biodiversity research strategy, concerning "Auditing the Ark-Science based Monitoring of Biodiversity*, Silkeborg. <http://biodiv.dmu.dk/1meetings/doc/conclusion>.

HINTERMANN U., WEBER D., 1999 – *Monitoring de la biodiversité en Suisse - rapport sur l'état du projet à fin 1998*, Office fédéral de l'environnement, des forêts e du paysage OFEFP, Berne.

OECD, 1993 - *Core Set of Indicators for Environmental Performance Review*. Environmental Monographs, 83. Paris.

MALCEVSCHI S., CAPETTA C., BUSA M., QUAGLIO G., BISOGNI G.L., 1999 – *Agroecosistemi piemontesi – Struttura e dinamiche*, Collana Ambiente 16, Regione Piemonte, Torino.

UNECE & EC, 2002 – *The Condition of Forests in Europe: 2002 Executive Report*. Ginevra. <http://www. Icp-forests.org/pdf/er_en.pdf>.

WATT A., YOUNG J., 2002 – *Auditing the ark – science-based monitoring of biodiversity: closing message*. Bioplatform *e-conference*, september 2002. <http://www.gencat. es/mediamb/bioplatform/summary.htm>.

MONITORING NETWORKS UNDER THE *CORPO FORESTALE DELLO STATO*

[Bruno Petriccione]

As regards to its institutional activities, the *Corpo Forestale dello Stato* has launched two specific monitoring programmes on the conditions of forest and Alpine ecosystems:

1) The Nation Integrated Network CONECOFOR for forest ecosystems monitoring was set up nine years ago and is currently surveys 32 permanent plots, spread throughout the Italian territory which cover the principal Italian forest ecosystems. The programme, conducted in the framework of the international Convention on Long-range Transboundary Air Pollution and in implementation of Regulation (EC) 2152/2003 on forest monitoring in the European Community (Forest Focus Scheme) studies the ecological interactions between the structural and functional components of forest ecosystems and large-scale pressure and change factors (atmospheric pollution, climate change, variations in levels of biodiversity),
2) The international Programme to Study the Effects of Climate change on Mountain Ecosystems (CLIMECO) co-promoted with the French *Office National des Forêts*, has the aim of creating a French-Italian network of permanent plots for the long-term monitoring of the effects of climate change on Alpine plant communities of the Maritime Alps and the Central Apennines for a period of at least 10 years (2003-2012).

The CONECOFOR Network (ALLAVENA *et al.*, 2001, MOSELLO *et al.*, 2002) was created and set up in 1995 by the State Forestry Corps (which operates within the Ministry for Agriculture and Forestry). The CONECOFOR Department of the State Forestry Corps is the national coordination centre and referent at an international level to the corresponding Pan-European Programme carried out by the European Union and by the United Nations Economic Commission for Europe (UNECE) in implementation of the international Convention on Long-range Transboundary Air Pollution, (ratified by Italy in 1982), and Ministerial Conferences Resolutions on the protection of forests in Europe, along with and Regulation (EC) 2152/2003. The programme is the evolution of studies conducted (1987) on a European network based on a 16 x16 km grid system, which currently consists of 260 sample plots throughout the territory. Annual assessments of the condition of tree crowns are carried out at these points. From a selection of points of the same grid, studies and analyses of the soil and leaves were conducted in 1995/6.

The Economic Commission Programme of the United Nation and that of the European Union, in which 21 countries participate, has the aim of keeping the conditions of forest ecosystems under control for a period of at least twenty years, through the in-depth study and monitoring of permanent plots which are representative of the entire European continent (UN/ECE & EC, 2002). Italy has participated in the Pan-European Programme on the effects of atmospheric pollution since 1995 with the programme CONECOFOR: the 13 Italian sites (out of 70) place Italy at the forefront in Europe for the number of areas studied (KLEEMOLA and FORSIUS, 2002).

The CONECOFOR Network is based on 31 permanent plots (Figure 7.12, Table 7.15) spread throughout the Italian territory that are representative of all the main forest communities in the country. Ten different studies have been carried out in the permanent plots: geological and geomorphological studies (preliminary), vegetation studies (annually), assessments of tree crown conditions (annually), analyses on the chemical content of leaves (every two years), soil analyses (every ten years), analyses of growth variations in trees (every five years), analyses of atmospheric deposition (on a continuous basis), meteorological studies (on continual basis), analyses of

Fig. 7.12 - Map of the permanent plots of the National CONECOFOR Network.

concentration of troposphere ozone (on continual basis), and biodiversity studies (experimental phase recently launched). The research centres of the *Corpo Forestale dello Stato*, MiPAF Institutes, the CNR, universities and other research bodies coordinate each study at a national level, ensuring the standardisation of methods (that are coordinated and continually updated at a European level), and the reliability of results (subjected to rigorous quality control procedures). Studies on biodiversity were started in 2003, on an experimental basis in the context of the European Programme Forest BIOTA (FISCHER and NEVILLE, 2003), to which 20 different countries participate. Seven key parameters regarding population are studied in twelve permanent plots from the Alps to Sicilia, according to methodologies harmonised at an international level (1) vegetation, (2) lichen epiphytes, (3) population structure, (4) deadwood, (5) invertebrate community, (6) naturalness and (7) landscape biodiversity.

The permanent plots, managed directly by the Offices of the *Corpo Forestale dello Stato* or in collaboration with local governments, each cover an area of 10-100 hectares, each containing two study grids of 5,000 sq. metres. The dominant species are *Fagus sylvatica* (10 areas), *Picea abies* (6), *Quercus cerris* (6), *Quercus ilex* (4), *Quercus petraea* (1), *Quercus robur*/*Carpinus betulus* (3) and *Larix decidua* (1).

In the first nine years of implementing the CONECOFOR network, a detailed and systematic description of the principal forest ecosystems present in Italy was made. Today we have a good knowledge of the ecological characteristics of 18 different forest communities in the Italian territory from the Alps to Sicily (PETRICCIONE, 2002). On the one hand, these indications have broadened our knowledge on forests, particularly with regards to the cause/effect relationship among various interagent factors. While on the other, they provide us with more elements to consider when considering what quality development and economic-political choices need to be implemented in order to guarantee a sustainable and compatible development together side nature conservation, and in particular, with regards to a renewable resource of fundamental importance, even economic, but above all ecological: the forest. The first data collected, in particular, indicate that deposition of nitrogenous substances reached peaks of more than 30 kg a year per hectare in the Padana Plain area, with high levels in all the other controlled areas, which even pollutes the water tables and watercourses. Even ozone concentrations had reached alarming peaks, up to 60-70 parts per billion, especially in summer, and in the southern most regions, causing great damage to forest vegetation (FERRETTI *et al.*, 2003).

The CONECOFOR Service of the *Corpo Forestale dello Stato* (Italy), the CNRS, the CEMAGREF and INRA (France) are partners in a consortium founded to implement the ALTER-Net Project. This is long-term biodiversity, ecosystem and awareness research project funded by the European Commission for the period 2004-2008 in the context of the 6th Framework Programme for Research. ALTER-Net is a partnership of 24 organisations from 17 European countries, coordinated by Natural Environmental Research Council (Centre for Ecology and Hydrology, UK) to develop durable integration of biodiversity research capacity at a European level. In this context, the State Forestry Corps and the French *Office National des Forêts* promote the international programme to study the effects of climate change on mountain ecosystems, the CLIMECO Programme. The process of rapid global warming is in fact threatening all levels of biodiversity in several sensitive ecosystems, such as the Alpine community in Southern Europe. All the authors foresee a mid-term degeneration process, followed by a long-term regression process, with an increase of the role of ruderal species. In fact, the ecosystems of high mountains that are determined by low temperature conditions are generally considered as being particularly sensitive to climate warming Therefore, high mountain ecosystems appear to be useful as "ecological indicators" of climate change effects because they have comparatively low biotic complexity, and abiotic factors, particularly climate, dominate over biotic factors, such as competition. Hence, climate change impacts on Alpine and nival vegetation are expected to be more pronounced than on vegetation at lower altitudes. In addition, impacts of human land use, which could mask climate-related signals, are largely negligible in many high mountain regions. The thermal life zones are compressed and their temperature-determined ecotones are narrow compared to the horizontal/latitudinal transition zones. Therefore, these narrow mountain ecotones are appropriate for an effective quantification of expected vegetation changes. Finally, high mountain systems can be found in all major zone biomes from tropical to polar latitudes. This favours their use for a global comparison of climate change effects on biocenoses in temperature-limited environments. On the basis of a series of historical data available and all models, the most dramatic climate changes will occur in the southern part of Europe, where a sharp drop in summer rainfall is fore-

For.	I.M.	Naz.	Name (City - Province)	Altit.	Dominant arboreal species
01	IT05	ABR1	*Selva Piana* (Collelongo - AQ)	1,500	*Fagus sylvatica*
02		BAS1	*Monte Grosso* (Potenza)	1,125	*Quercus cerris*
03	IT06	CAL1	*Piano Limina* (Giffone - RC)	1,100	*Fagus sylvatica*
04		CAM1	*Serra Nuda* (Corleto Monforte - SA)	1,175	*Fagus sylvatica*
05	IT07	EMI1	*Carrega* (Sala Baganza- PR)	200	*Quercus petraea*
06	IT08	EMI2	*Brasimone* (Camugnano - BO)	975	*Fagus sylvatica*
07		FRI1	*Bosco Boscat* (Castion di Strada - UD)	6	*Quercus robur, Carpinus betulus*
08		FRI2	*Tarvisio* (Tarvisio-UD)	820	*Picea abies*
09	IT09	LAZ1	*Monte Rufeno* (Acquapendente - VT)	690	*Quercus cerris*
10	IT10	LOM1	*Val Masino* (Val Masino - SO)	1,190	*Picea abies*
11	IT11	MAR1	*Roti* (Matelica - MC)	775	*Quercus cerris*
12		PIE1	*Val Sessera* (Bioglio - BI)	1,150	*Fagus sylvatica*
13		PUG1	*Foresta Umbra* (VicoGargano - FG)	800	*Fagus sylvatica*
14		SAR1	*Marganai* (Iglesias - CA)	700	*Quercus ilex*
15		SIC1	*Ficuzza* (Godrano - PA)	940	*Quercus cerris*
16	IT12	TOS1	*Colognole* (Livorno)	150	*Quercus ilex*
17	IT03	TRE1	*Passo Lavazè* (Trento)	1,775	*Picea abies*
18		UMB1	*Pietralunga* (Pietralunga - PG)	725	*Quercus cerris*
19	IT13	VAL1	*La Thuile* (La Thuile - AO)	1,740	*Picea abies*
20		VEN1	*Pian di Cansiglio* (Vittorio Veneto - TV)	1,100	*Fagus sylvatica*
21		ABR2	*Rosello* (Rosello - CH)	960	*Quercus cerris, Abies alba*
22		LAZ2	*Monte Circeo* (S. Felice Circeo - LT)	190	*Quercus ilex*
23		LOM2	*Giovetto* (Borno - BS)	1,260	*Picea abies*
24		LOM3	*Valsassina* (Moggio - LC)	1,250	*Fagus sylvatica*
25		TOS2	*Cala Violina* (Scarlino - GR)	30	*Quercus ilex*
26		TOS3	*Vallombrosa* (Reggello - FI)	1,170	*Fagus sylvatica*
27	IT01	BOL1	*Renon* (Renon-Collalbo - BZ)	1,740	*Picea abies*
28		LIG1	*Monte Zatta* (Borzonasca - GE)	1,290	*Fagus sylvatica*
29		PIE2	*Bosco Vedro* (Cameri - NO)	135	*Quercus robur, Carpinus betulus*
30		PIE3	*Devero* (Baceno - VB)	1,860	*Larix decidua*
31		VEN2	*Bosco Fontana* (Marmirolo – MN)	60	*Quercus robur, Carpinus betulus*

Table 7.15 - Permanent monitoring areas of the national network CONECOFOR (code ICP Forests – For., code ICP *Integrated Monitoring of Ecosystems* – I.M., national code – Naz., altitude in meters a.s.l.).

seen (about 30%) along with significant increases in temperatures (about 3-4°C), particularly in those areas which have a montane-Mediterranean type climate. In particular, according to the last IPCC Report (2001), Southern France and Central and Southern Italy have been, and will be (in the next 50 years) the areas most affected.

Based on data gathered in last century on the Central Alps, long-term upward shifts in the distribution of some species has been documented (GRABHERR *et al.*, 1994). The same methodological approach is now applied within the GLORIA Project (see section *International and European Initiatives*) with the objective of verifying if similar movements of species has been observed in the high mountain summits in the Alps. On the basis of data gathered over the last 9-16 years in permanent plots from 1,000 to 2,300 metres a.s.l., recent changes in the composition and species richness in Alpine plant communities in the Central Apennines has been documented (PETRICCIONE, 2001, 2004). A preliminary comparative study of changes in species composition, biological forms, life strategies and morphological-functional types has shown that there has been 10-20% change in species composition in communities living above the natural limit of trees, together with a significant increase in xerophytic and stress-tolerant species. These data can be explained considering the great reduction in snowfall, the significant increase in minimum daily and monthly temperatures, and a reduction in summer rainfall, widely documented by long-term meteorological observations.

In this context, the development of a network of permanent plots, the detailed study and tempest warning with regards the effects of climate change on Alpine plant communities of the Maritime Alps and Central Apennines is a clear priority, both at a national and European

level. The CLIMECO Programme, co-promoted by the Italian State Forestry Corps and the French *Office National des Forêts* is based on the selection of 3-4 sites per area, each of which is representative of a well-defined plant community, according to the phytosociological methods, along an aridity gradient from mesophyll to xerophytic communities, in areas with low-level grazing and negligible trampling impact. Phytosociological surveys are carried out at each site from 3 to 5 times to reach an acceptable statistical level (3-5 permanent plots of 100 sq. metres each, 10x10 metre areas marked permanently on the ground, not contiguous but comparable from an ecological point of view.

The Italian plots will be located in the Central Apennines (Monte Velino and Gran Sasso d'Italia), from 2,125 to 2.270 metres a.s.l. which will represent four communities: Alpine tundra (*Saxifrago speciosae-Silenetum cenisiae*), xeric high-mountain grasslands (*Pediculari elegantis-Seslerietum tenuifoliae*), mesophilous high-mountain grasslands (*Luzulo italicae-Festucetum macratherae*) and high-mountain snowbed grasslands (*Trifolio thalii-Festucetum mirophyllae*). Data relative to the years (1986) 1993, 1999 and 2001 (9-16 years) are already available (though with only one repetition per site). The French sites will be situated in the Maritime Alps (Alpes de Haute Provence, Col des Champs), at a height of 2,200-2,300 metres a.s.l., with three representative communities: xeric high-mountain grasslands (*Seslerio-Avenetum montanae*), ridge and scree facies, and high-mountain snowbed grasslands (mixed communities of *Trifolium thali* and *Festuca rubra* s.l.).

Detailed phytosociological surveys will be conducted every year on each plot in the most suitable season from 2004 to 2013 (10 years) comprising a complete inventory of the phanerogam species with an estimate of their cover using the Braun-Blanquet scale. Meteorological measurements of rainfall, temperature, extent and duration of snowfall will be carried out at comparable sites.

This monitoring activity should identify and quantify the signs of degeneration and regression processes underway in high-altitude plant communities, an increased growth of xerophytic and stress-tolerant species along with a decline in microtherm, mesophyll and competitive species. On the basis of changes observed in Alpine communities, the current management of the territory could be improved by (1) increasing the level of protection of more sensitive or threatened biotopes and biocenoses, with their inclusion in areas under greater protection, (2) the set up of networks and systems of protected areas to improve the ecological relationship between biocenoses and allow the migration of species at risk, (3) invert the trend to develop tourist infrastructures based on winter sport and convert them into services for sustainable activities throughout the year, (4) the establishment of a monitoring network to diagnose likely changes.

The possible end users of the project could be: (1) at a national level, the Ministry for Agriculture and Forestry, the Ministry for the Environment Land and Sea Protection, National Park and State Reserve Authorities; (2) at an international level, the European Commission (DG Agriculture and Environment), the UN/ECE ICP - Integrated Monitoring of Ecosystems Programme, the European Environment Agency, the UN/IPCC Group, etc. The project is promoted by the *National des Forests* (France) and the State Forestry Corps (Italy), with the participation of the governing board of the Orientata Monte Velino Nature Reserve and Gran Sasso and Monti della Laga National Park.

Bibliography

ALLAVENA S., ISOPI R., PETRICCIONE B., POMPEI E., 2001 – *Programma Nazionale Integrato per il Controllo degli Ecosistemi Forestali. Secondo rapporto. 2000.* Ministero per le Politiche Agricole e Forestali (Roma).

FERRETTI M. (a cura di), 2000 – *Integrated and Combined (I&C) evaluation of intensive monitoring of forest ecosystems in Italy. Concepts, methods and First Results.* Annali Istituto Sperimentale per la Selvicoltura, Special Issue 1999 (Arezzo), 30.

FERRETTI M., BUSSOTTI F., FABBIO G., PETRICCIONE B. (a cura di), 2003 – *Ozone and forest ecosystems in Italy. Second report of the Task Force on Integrated and Combined (I&C) evaluation of the CONECOFOR programme.* Annali Istituto Sperimentale per la Selvicoltura, Special Issue 1999 (Arezzo), 30.

FISCHER R., NEVILLE P., 2003 – *The ICP Forests approach for future contributions to forest biodiversity monitoring at stand level in Europe.* In: MARCHETTI M., BARBATI A., ESTREGUIL C., LARSSON T.-B. (a cura di), *Monitoring and Indicators of Forest Biodiversity in Europe, From Ideas to Operationality.* Abstract booklet. European Communities, SP.I.03.163.

GRABHERR G., GOTTFRIED M., PAULI H., 1994 – *Climate effects on mountain plants.* Nature, 369, 448.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGES, 2001 – *Climate Change 2001: Impacts, Adaptation and Vulnerability.* Cambridge Univ. Press, UK.

KLEEMOLA S., FORSIUS M. (a cura di), 2002 – *11th Annual Report 2002. UN/ECE ICP Integrated Monitoring od Air Pollution Effects on Ecosystems.* The Finnish Environment, 567. Finnish Environment Institute. Helsinki.

MOSELLO R., PETRICCIONE B., MARCHETTO A. (a cura di), 2002 – *Long-term ecological research in Italian forests ecosystems.* J. Limnol., 61 (Suppl.1).

PETRICCIONE B., 2001 – *L'impatto dei cambiamenti climatici sugli ecosistemi montani delle aree protette degli Appennini Centrali.* Tesi di specializzazione in Gestione dell'Ambiente Naturale e delle Aree Protette, Università degli Studi di Camerino, Italia.

PETRICCIONE B., 2002 – *Vegetation survey and assessment in the CONECOFOR permanent plots.* J. Limnol., 61 (Suppl. 1).

PETRICCIONE B., 2003 – *First results of the ICP Forests biodiversity test-phase in Italy.* In: MARCHETTI M., BARBATI A., ESTREGUIL C., LARSSON T.-B. (a cura di), *Monitoring and Indicators of Forest Biodiversity in Europe* – From Ideas to Operationality, Abstract booklet. European Communities (SP.I.03.163).

PETRICCIONE B., 2004 – *Short-term changes in key plat communities of Central Apennines (Italy).* Acta Botanica Gallica, 151 (3).

UN/ECE & EC, 2002 – *Intensive Monitoring of Forest Ecosystems in Europe. Technical Report 2002.* Brussels and Geneva.

CONVENTION ON COMPLETION OF NATURALISTIC KNOWLEDGE IN ITALY

[Carlo Blasi, Ilaria Anzellotti, Piera Di Marzio]

This Convention, coordinated by the Plant Biology Department of the University of Roma *La Sapienza* is the most important commitment that has ever been carried out in a scientific and systematic manner since the CNR Environment Project in the 1970s - 1980s, and it has involved several university departments, the National Research Council (CNR), a hundred or so researchers from several universities and, indirectly, all the principal scientific societies.

The principal aim was to place all homogeneous naturalistic data for the entire national territory on a scale of 1:250.000.

Apart from preparing a solid knowledge base for monitoring purposes, the results of this work are useful in planning and managing natural habitats, as well as in small-scale country planning.

The vegetation series map and floristic studies on a national scale

The cartographic approach that was utilised began from a hierarchical landscape classification of the territory based on the supposition that the different ecosystems are identifiable given their homogeneity on the scale of observation chosen. The hierarchy obtained covers landscape regions defined on a macroclimatic basis, landscape systems defined on lithologic basis, and landscape subsystems defined on geomorphologic basis.

It should be pointed out that the concept of "vegetation series" on a scale of 1:250,000 takes on particular importance. As the methodological process is targeted at pinpointing "homogeneous units" the activity is aimed at identifying mapping polygons mainly in keeping with a vegetation series. To offer additional indications on very complex units in morphologic and bioclimatic terms, it was decided to indicate the prevalent series and possibly the subordinate series. Moreover, in the presence of great ecological and morphological gradients that are very effective in making catenal ambits even in very limited spaces (beaches, high elevation carbonatic landscapes, river incisions and valleys, etc.) a passage was made from the series to the geosygmetum.

The vegetation series map is accompanied by a monograph (one for each administrative region) which contains spatialised information on the map with a description of the vegetation stages present in a given territory, reaching a degree of detail which the scale of work (1:250,000), did not permit to be mapped.

The vegetation series map, which provides insight into the real vegetation in addition to the potential natural vegetation on the basis of the present bioclimatic and edaphic conditions, is an essential document for monitoring as it provides the basis upon which to create derivate thematic maps (for example, the map on environmental quality on the basis of vegetation, the map of environmental landscape units, etc.) that are indispensable when defining the general aspect of the territory.

Floristic studies at a national level were undertaken to fill in some knowledge gaps about flora distribution regards to endangered, rare, endemic or little observed flora in Italy. For more information regarding the results obtained see section *Vulnerable, endemic and rare species of the Italian vascular flora*.

The land cover map

The general outline in the thematic organisation of the land cover map was that of the CORINE Land Cover system. It fully maintains the first three levels CLC, while it further details the categories of arable land (CLC 2.1), forests (CLC 3.1), and shrub and/or herbaceous vegetation associations (CLC 3.2) with a fourth level. The purpose is to integrate the CORINE Biotopes hierarchically with the land and habitat typologies listed in Council Directive 92/43/EEC and to create a classification system that can be integrated with the other thematic or multidisciplinary analyses provided in the other modules of the Convention (vegetation series analyses, landscape studies, spatial ecological analyses). Moreover, this fourth level allows the thematic component to be recognised exploiting the full potential of the CLC database, integrating it with other sources, thus providing a classification that can be applied to all areas and utilise data from satellite images taken at various times of the year, also for subsequent updating and monitoring activities.

Extending zoological knowledge in the national territory

Dozens of experts including specialists from abroad were involved in the project to update the Checklist of Italian Fauna species regarding many taxonomic groups and collect data relative to the distribution of 3,600 vertebrate and invertebrate species.

The criteria utilised in choosing the species was set by the coordinators of the project through a previous screening of the national checklist and after having heard the opinions of experts of single species. The selection criteria established *a priori* were: that the taxonomy of species was sufficiently stable, the availability of experts informed on the nomenclature of the families selected; that the biology and habitat preference was well known; ease in sampling; the family to which the belonged must have an ample distribution and wide ecological valence, though made up of species with a great degree of habitat specialisation; representiveness, that is, belonging to the most important taxonomic groups and present in different natural habitats; valence as bioindicators; biogeographical interest; be of economic or commercial importance.

Once the *taxon* was selected (family or *taxon* of higher rank), then all the species of that *taxon* were considered in the project to avoid any kind of arbitrary or individual choice.

To obtain the most reliable data, only the land and freshwater species were considered, excluding the marine component of fauna for which the georeferenciation of findings and the elaboration of data obviously requires a different approach.

The *vertebrates* considered in the Checklist were chiropterans, insectivores, rodents, reptiles, amphibians, agnates and freshwater osteichthyes, while the groups of *invertebrates* included molluscs, vertiginid gastropods, arthropods, carabid coleopterans, trechini and pterostichini, scarabids, *Osmoderma eremita*, lucanids, tenebrionids, alticine chrysomelids, cerambicids, curculionids, tipulids, sirfids, conopids, apoideans, chrysidids, scoliids, auchenorrhyncha, myrids, tingids, leptopodids and saldids, hepialids, noctuids, *Eriogaster catax* and *Callimorpha quadripunctaria*, araneid salticids, and isopod crustaceans.

Knowledge regarding of the systematics of some groups was extended as new species and subspecies were described, and some age-old disputes regarding the actual presence of several species in Italy were resolved by the experts involved in this project.

The data collected provide a national cover of species on the scale that was adopted (1:250,000), and they are all georeferenced and complied in a databank. The great quantity of geonomic data has led to "cronogeonemie" that provide an immediate image of the distributive dynamics which allows the state of growth or contraction of populations of species to be verified, thus quickly resolving problems relative to monitoring, conservation, evaluation, and management of the Italian territory.

Bioclimatic studies

The Phtyoclimatic Map of Italy was the outcome of these studies and a summary of the results obtained are present in the chapter on *Biodiversity and climate*.

Background description to coastal biocenoses

The map of coastal biocenoses was drawn up along with that of the map of coastal landforms and sediment types, the map of water quality, the distribution map of protected marine species listed in the Habitats Directive and Annex II of the Protocol on Especially Important Protected Areas for the Mediterranean (ASPIM – Barcelona Convention, 1995), and last of all, the map of the principal allochthonous species recently introduced into Italian marine waters.

This marine section of the study was limited to three miles from the coast and down to a depth of 50 metres. For the classification of biocenosis, reference was made to a subdivision of the levels[1] of the benthic realm: only the supralittoral, infralittoral, circalittoral and batial zones were taken into consideration in this project, while only the infralittoral and a part of the circalittoral biocenoses were mapped, due to the limited stretch of the tidal and supralittoral zones along the Italian coastline.

In order to provide a complete picture of the characteristics of the principal benthic biocenosis present along the Italian coast, descriptive summaries were compiled mostly utilising data from literature.

Naturalistic and ecological knowledge in drafting a national plan for the wetlands and the creation of a national wetlands system

A national system for the wetlands was formulated based on knowledge and the elaboration of operational proposals to manage a network of ecological systems. Hence, in information-based system was created to standardise the environmental data available (mainly physical, ecological, biological features, together with anthropogenic disturbance) and to identify the environmental parameters to evaluate the quality, conservation status,

[1] The level is the vertical space of the benthic marine domain in which the ecological condiction, depending on the situation with respect to the see level, are basically fairly constant or vary regurarly within the two critical levels that delimit the level (supralittoral, infralittoral, circalittoral, bathyal, abyssal, adal).

vulnerability, and sensitivity of species, habitats and ecosystems of the wetlands areas, as well as support the elaboration of monitoring activities.

The project called for updated knowledge of the wetlands nation-wide with particular reference to documentation available on sites proposed in accordance with the Ramsar Convention and the Habitats and Bird Directives, the identification of parameters (indicators and descriptors) to be used in the classification and evaluation of the ecological integrity and vulnerability of the wetlands validated in sampling sites of the principal ecosystem typologies (bogs, swamps, freshwater marshes, sandy beaches, and vernal pools), and the elaboration of information-based support regarding methods and procedures for ecological monitoring to be placed at the disposition of wetland management. Moreover, the project entailed case studies to define criteria and levels of sustainable management of wetlands in which important economic activity takes place through the optimisation of intervention and management policies based on an analysis of alternative scenarios that consider the economic/production factors as well as environmental and social costs.

FROM THE CHECKLIST TO THE CKMAP: THE COMPUTERISATION OF ITALIAN FAUNA

[Fabio Stoch]

GIS is the breakthrough hardware and software system adopted for the storage, retrieval, mapping, and analysis of geographic data regarding fauna, as it is vital in the concrete application of knowledge gained so far for fauna management and protection. In fact, GIS was used to compile all the findings from a complex study of Italian fauna, which has involved practically all the taxonomy and fauna experts in Italy for ten years, the result of a synergic relationship between the Scientific Committee for Italian Fauna and the Nature Protection Directorate of the Italian Ministry for the Environment Land and Sea Protection. As a result of this effect, the project regarding the Checklist of Italian Fauna Species was created which contains list of more than 57,000 species published under the aegis of the European Commission, from 1993 to 1995. The next step was the publication of the volume Checklist and Distribution of Italian Fauna that brought the so-called CKmap project (acronym from ChecKlist mapping) to its natural conclusion. This project originated from collaboration between the Nature Protection Directorate, the Scientific Committee for Italian Fauna, the Civic Museum of Natural History of Verona, and the Ecology Department of the University of Calabria. A congruous number of *taxa* (more than 10,000 species) considered good faunistic and biogeographic indicators, suitable in providing a representative outline of Italian land and freshwater fauna were selected from the Checklist. Thanks to the efforts of about one hundred experts, the following elements for each species were compiled into a databank: the ecological characteristics, the chorology, its conservation importance/value, habitat preference, and its puntiform distribution in the Italian territory taken from bibliography, museum collections and new sources. Currently, the databank comprises more than 531,000 records on distribution. Each record is georeferenced and therefore can be mapped (via the interactive CKmap software specifically designed or through GIS programmes) to create thematic atlases, detailed maps of range distribution, as well as maps which identify biodiversity hotspots, rare and endemic species. This makes it an important instrument of faunistic knowledge that covers a fifth of the animal species present in Italy. Above all, it is a concrete tool that allows faunistic data to be applied biodiversity assessment, to draw up red lists, to create of ecological and environmental quality models, and to plan conservation strategies. The subsequent step for biodiversity management is the integration of the CKmap database with the other knowledge-based tools produced in the "GIS Natura" Project carried out in collaboration with the Nature Protection Directorate of the Milan Polytechnic.

THE MAP OF NATURE PROJECT

[Marisa Amadei]

The Map of Nature project (*Carta della Natura*) resulted from the Framework Law for Protected Areas No. 394/91. The objective according to specifications indicated in the law itself was to evaluate the conditions of the natural environment, identifying the natural values and the environmental vulnerability of the country. The end product provides extremely useful information to support territorial planning for state and local governments.

As provided for by the Framework Law, the methodological structure of the project involves the identifica-

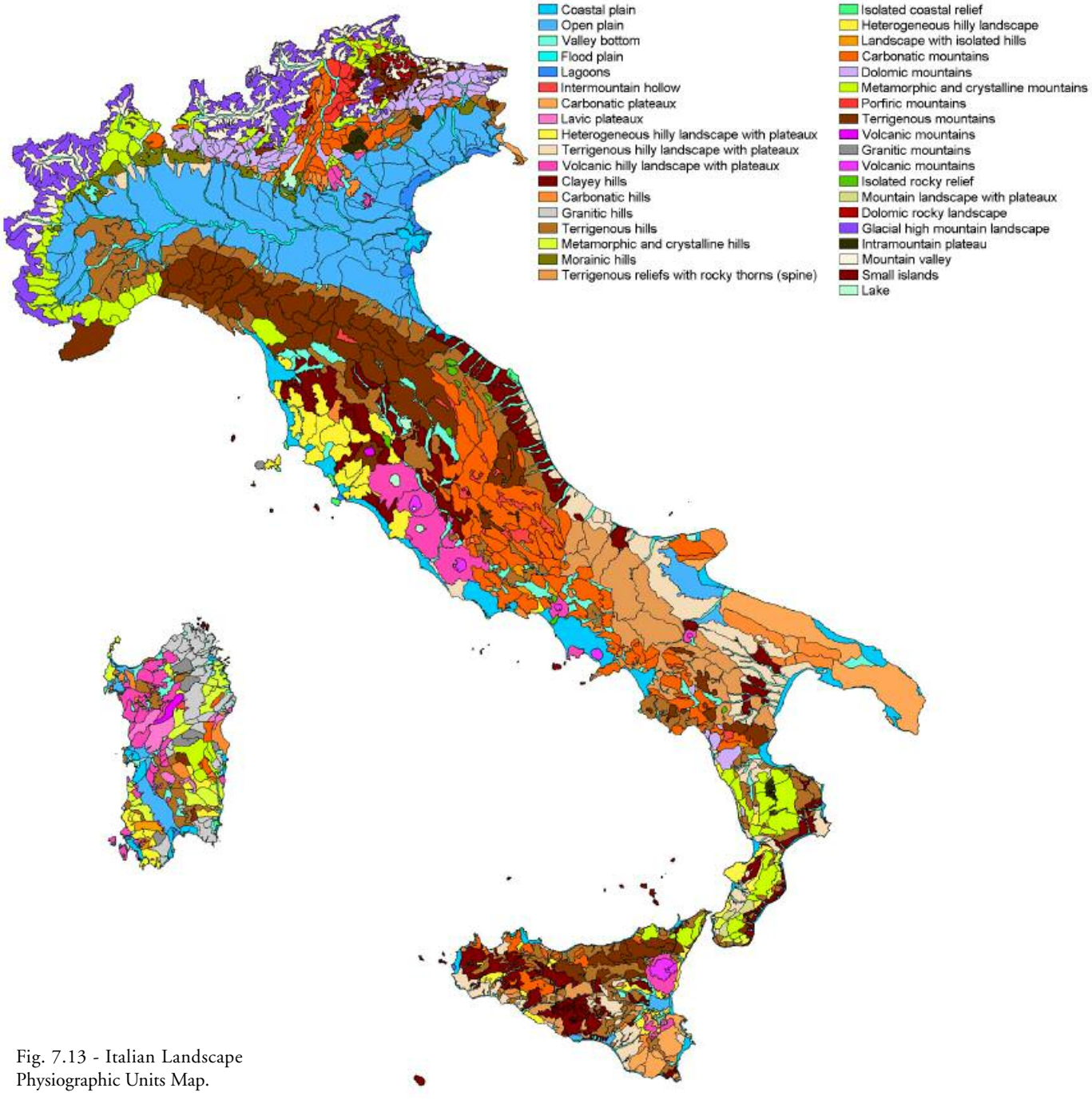

Fig. 7.13 - Italian Landscape Physiographic Units Map.

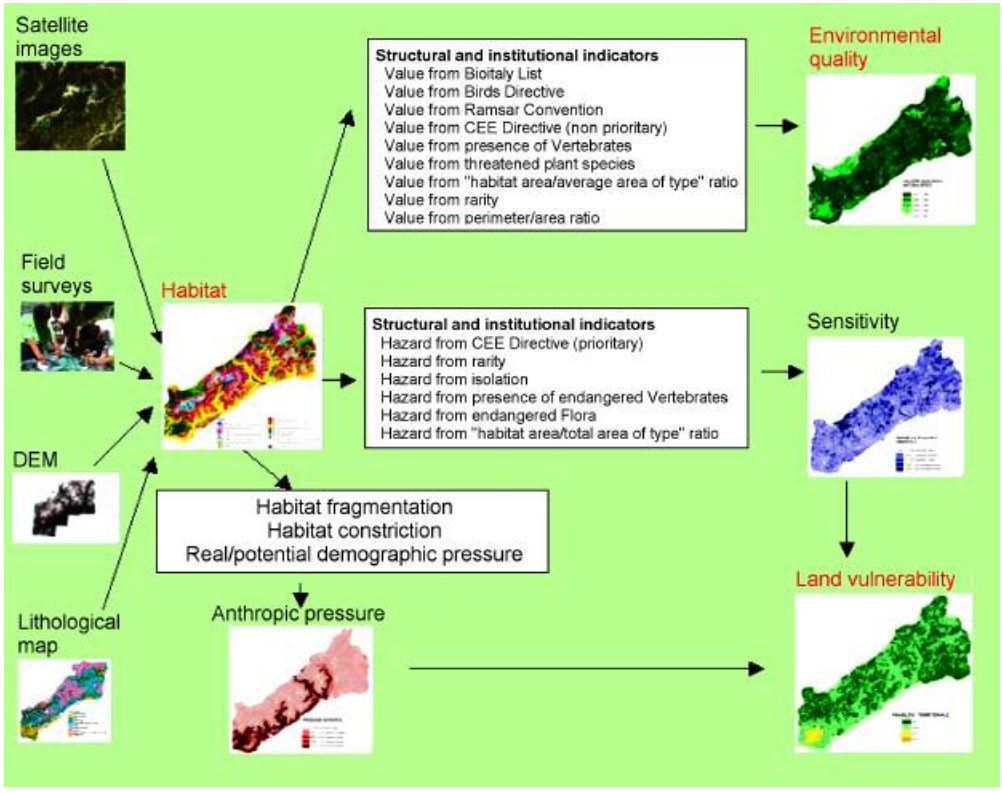

Fig. 7.14 - Methodological system of the *Carta della Natura* (Map of Nature) on a scale of 1:50.000.

tion of homogeneous "landscape types" which, on the basis of suitable "indicators", were used to evaluate ecological quality, anthropogenic pressure and vulnerability. The entire project is structured on a Geographical Information System.

By identifying and delimiting the landscape type that characterises one defined geographical area using integrated methodologies such as remote sensing, ground controls, thematic data and maps (CLC, geological maps, forest maps, etc.), a "landscape unit" was obtained which represents the fundamental territorial unit for the *Carta della Natura* system. The study was conducted at two levels: landscape types and units, which define Italian landscapes at a regional level, were identified on a scale of 1:250,000, showing typical arrangements of physical, biotic and anthropogenic features, while the various habitats were classified on the basis of the European Nomenclature Code CORINE Biotopes on a scale of 1:50,000.

The Italian Landscape Physiographic Units Map is prepared on a scale 1:250,000 for the entire national territory (Figure 7.13 on the previous page). The methodology adopted to evaluate environmental quality and territorial vulnerability of each landscape unit was adjusted in the Regions of Veneto and Friuli-Venezia Giulia (publication APAT No. 17/2003 "Manuals and Guidelines"). It will have to be integrated with the thematic maps on the same scale elaborated in the Italian Ministry for the Environment Land and Sea Protection project "Completion of Naturalistic Knowledge".

The methodology utilised to create the Habitats Map on a scale of 1:50,000 (Figure 7.14) is mostly based on LandsatTM satellite images, developed in various stages which requires the continuous collaboration of those who interpret and classify the satellite images and the botanists who provide the necessary data from direct knowledge of the territory.

The evaluation phase on a scale of 1:50,000 needs the elaboration of the following maps:

- Map of Environmental Quality
- Map of Anthropogenic Pressure
- Map of Ecological Sensitivity
- Map of Territorial Vulnerability.

The thematic aspects described in each of the abovementioned maps refer to each habitat type and the methodology applied requires the use of appropriate ecological-naturalistic indicators, some of which are simply found through specific computer-based procedures while others are obtained from existing official data for the entire national territory.

The ecological-naturalistic value and the ecological sensitivity is assessed by considering similar indicators which, apart from the plant and animal species present in a habitat, take into consideration several parameters linked to the size, form and rarity of habitats, as well as their inclusion or not in European Community lists for the various types of habitats. In the case of sensitivity, the same parameters are considered along with particular reference to endangered plant present in the official Red Lists.

Anthropogenic pressure is calculated on information from nation surveys carried out by ISTAT. A calculation is made of the degree of disturbance in habitats from fragmentation due to road and rail infrastructures and by its proximity to environmental detractors and urban areas.

Territorial vulnerability represents a combination of ecological sensitivity and current and/or potential anthropogenic pressure, and expresses the degree of fragility in a given habitat linked to its intrinsic natural sensitivity and to its actual position in the socio-natural fabric of the territory.

The Map of Nature on a scale of 1:50,000 is in its final stages for the first 7 million hectares of the national territory. Mapping is now underway in numerous other regions of the national territory, in collaboration with the Regional authorities or with the ARPA agencies that operate in the territory.

The methodological approach adopted in the Map of Nature can also introduce data regarding the state of biodiversity, as in the case of the Bellunese Dolomites National Park. In this case, species richness and the trend of biodiversity loss were also considered with regards to the Environmental Quality Map and in the Territorial Vulnerability Map respectively (APAT publication No. 46/2004 in the series "Reports").

GIS NATURA: THE ITALIAN NATURALISTIC GEOGRAPHIC DATABASE

[Gianmarco Paris]

The databanks at the disposal of the Italian Ministry for the Environment Land and Sea Protection Nature Protection Directorate are a complex and articulated series of indispensable tools to manage the territory and to plan strategies for safeguarding flora, fauna, and habitats. Consulting heterogeneous databanks, of different origin and structure, capable of mapping at different scales and with differing degrees of detail, is a complex and onerous operation in terms of time and human resources. The integration of databanks and the user-friendly use of a single geographic information system is therefore a necessary step in obtaining work tool that facilitates rapid access to existing information. *GIS NATURA* was created on the basis of this premise; the Geographic Information System (GIS) on Naturalistic Knowledge in Italy was launched through a convention between the Nature Protection Directorate and the University of Milan. This geographic informative system is equipped to integrate all the following databases and information into a single system: the Checklists of Fauna, Flora, Fungi, the Fauna Distribution database (CKmap, Mito 2000) and Flora Distribution database (Locflora), data on marine biocenoses, distribution models of Italian vertebrates (REN), the distribution of priority habitats, land use CORINE Land Cover IV level, vegetation series, phytoclimatic, ecopedological and landscape maps, the delimiting of parks and protected areas, sites of Community Importance (SCIs), and Special Protection Areas (SPAs). It is now possible to consult the databases in a user-friendly manner and find information that ranges from single species, taxonomic groups, protected areas to administrative limitations. This is a versatile tool that is not only useful for biodiversity conservation in the managing the territory, but also for basic and applied scientific research as well as evaluations on environmental impact. Last of all, *GIS Natura* is a flexible tool that can be continually updated and extended. Future integration with other mapping tools at the disposal of local authorities should finally allow the needs of biodiversity management and protection to be integrated with those of territorial planning in the broadest sense of the word.