CONSERVATION OF MARGINAL AREAS IN PROTECTED TERRITORIES: THE OJCÓW NATIONAL PARK – CASE STUDY

ZBIGNIEW J. WITKOWSKI,[1] STEFAN MICHALIK,[2] PAWEŁ ADAMSKI[2]

[1] Faculty of Ecology and Environmental Management, Academy of Physical Education, al. Jana Pawla II 78, 31-571 Krakow, Poland, e-mail: witkowski@iop.krakow.pl
[2] Institute of Nature Conservation, Polish Academy of Sciences, al. Mickiewicza 33, 31-120 Kraków, Poland

Abstract

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Abundant literature concerned with flora and fauna of the Ojców National Park (ONP) allowed to reconstruct changes occurring there during the last 150 years. Human activity in the area increased the number and diversity of ecosystems (plant communities). Taking of that site under protection resulted in a decrease in spatial differentiation and number of ecosystems, mainly semi-natural chalk grasslands and semi-open bushy habitats. This have caused great changes in flora and fauna. A marked decrease in the number of species confined to water-marshy and xerothermic habitats and a slight decrease in shade-loving and oligothermic species are observed. Only meadow and pasture species increased in number during the last 150 years.

Landscape and environmental changes occurring around and within the ONP lead to increasing isolation of local nature and growing rate of autochtonous species extinction. As the rate of species immigration to the Park can not be influenced the authors decided that conservation work should be focused on decreasing the rate of species extinction in the area.

The authors' proposals are:

- to maintain a considerable diversity of ecosystems in the Park, with special regard to semi-natural ecosystems
- to create and maintain local source habitats supporting source populations
- to create 'species packing' corridors
- to create 'walking sources' for chalk grassland ecosystem species within corridors.

Key words: Ojców National Park, biodiversity, viable populations, conservation management, marginal areas, immigration, extinction

Introduction

Polish nature conservation legislation requires that each protected area at the rank of national park, landscape park and nature reserve should have an overall conservation plan elaborated (Chmielewski, 1996). In the case of Ojców National Park that plan covers a wide variety of topics and includes a number of so-called operation plans for conservation of inanimate nature, flora, fauna, individual ecosystems, historical values, as well as a tourist management plan and a scientific research project.

The present elaboration covers problems of living nature (flora and fauna) conservation with special regard to biodiversity conservation and conservation of rare and threatened species. Plans for biodiversity conservation and threatened metapopulations conservation may and should offer solutions at a landscape scale. This will make the understanding of assumptions of that part of the plan and the integration with other parts of the overall plan easier.

The application of such ecological theories as island biogeography (MacArthur, Wilson, 1967) and metapopulation (Hanski, 1991; Harrison, 1994; May, 1994), which are theoretical foundations of biodiversity and viable populations conservation, to conservation practice encounters difficulties. Not going into complicated reasoning, we assume that these theories indicate two spatial elements favoring the durable existence of species in a biocoenose and patches within a population: size of protected ecological unit (community or population) and connections between the identical or similar units.

The present paper shows our original method of maximizing biodversity and supporting viable populations of threatened species through management of spatial structure, composition and stability of ecosystems in a landscape (Michalik, 1992; Witkowski, 1982).

Description of the Ojców National Park and methods of inventories

The Ojców National Park, covering an area of 1590 ha, comprises the deep carstic canyons of the Prądnik and Sąspówka valleys (Fig. 1), the most valuable part of the Kraków-Częstochowa upland, built of Jurassic limestone. The diversified landscape affect the Park's climate (Klein, 1974) which shows certain similarities (in insolation, air temperature amplitudes and temperature inversion) to the climate of mountain regions. To the diversification of the Ojców landscape contributed also the historical and contemporary man's husbandry.

The vegetation of the Park includes forest, brushwood, meadow, pasture, arable field, chalk grassland and bare rock ecosystems. The area is cut by two watercourses: the Prądnik river and Sąspówka stream. There are also some small artificial ponds.

Most of the park area is covered by forests (1257 ha), non-forest areas occupy 335 ha, including 253 ha of arable land (meadows, pastures, fields) and 82 ha of other non-forest areas (also water).

The exceptional species richness of the Park is connected with the presence of two relic groups of taxa: (1) mountain and boreal-mountain, which have survived here from the postglacial cool period, and (2) thermophilous, Subpontic and Submediterranean, inhabiting that area from the postglacial climatic optimum before the incoming of man, and others that invaded the site together with man, accompanying deforestation of extensive areas a few thousand years ago. These species are most numerously represented among plants (Michalik, 1983) and invertebrates, and they are especially well identified among beetles (Pawłowski et al., 1994).

Conservation postulates and solutions presented in this paper gave priority to preserving species richness of the extremely cool and shady habitats, and chalk grassland, xerothermic habitats. Maintenance of these habitats is crucial for biodiversity conservation and conservation of viable populations of threatened and disappearing species.

Changes in land use in the ONP and its environs were summarized in tables. On the basis on data given by the above-cited authors, indicated were these alterations of the environment which had a decisive influence on the flora and fauna diversity and fate of particular species.

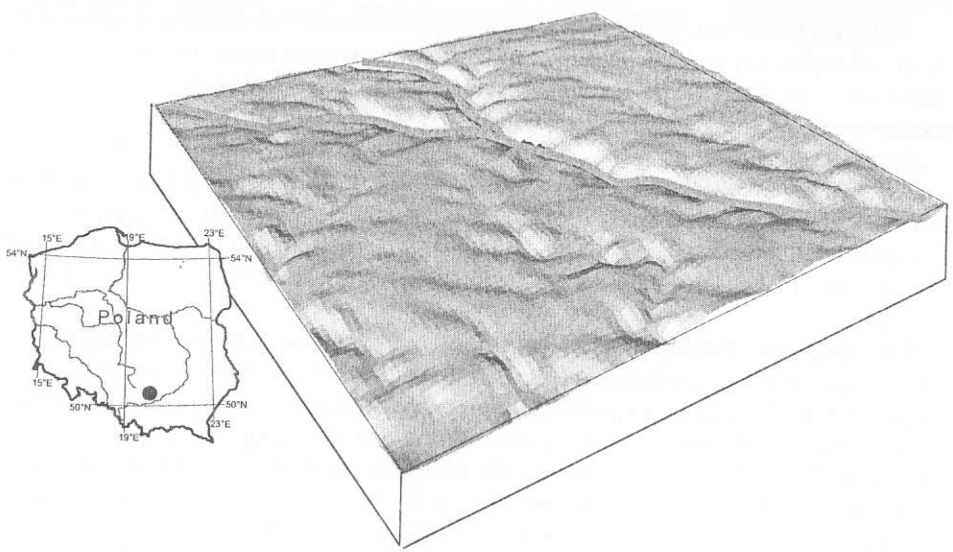

Fig. 1. Landscape view on the relief and situation of the Ojców N.P. (with small point localization of ONP in the large scale).

Data concerning changes in the vegetation were taken from three sources (Fig. 2):

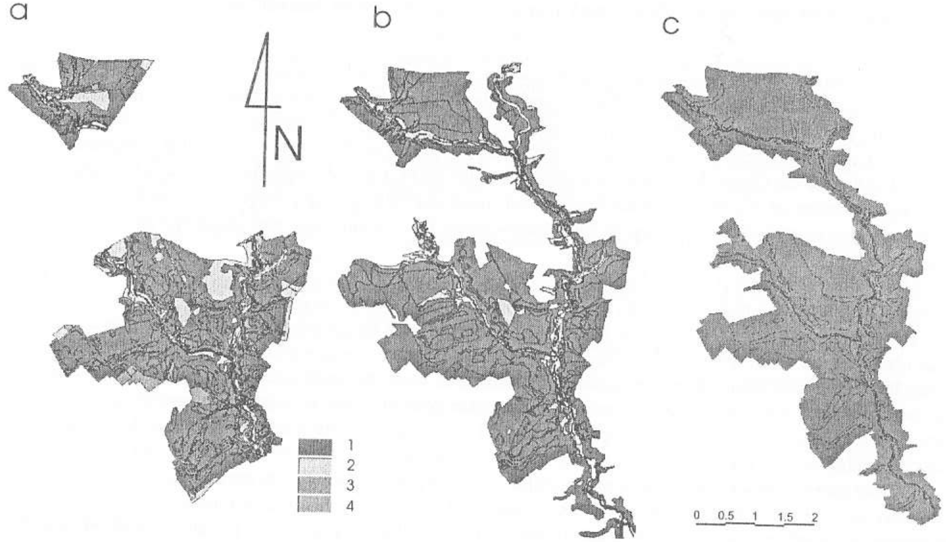

Fig. 2. Vegetation maps of the Ojców national Park: a – actual vegetation in the turn of fifties (Medwecka-Kornaś, Kornaś, 1963), b – actual vegetation in the turn of eighties (Michalik 1989), c – potential vegetation (Michalik). 1 – forests, 2 – open ecosystems, 3 – fresh afforestations, 4 – shrubs.

1. The map of potential plant communities prepared by one of the authors (S. Michalik) for the present elaboration. The map shows the pattern of plant communities that would have developed without man's interference (potential natural communities).
2. The map of plant communities of the Park, produced just after its creation (Medwecka-Kornaś, Kornaś, 1963). That map illustrates the contemporary layout, an effect of various transformations presented in the tables in this paper.
3. The map of plant communities of ONP, elaborated at the turn of the eighties. It shows alterations of plant communities in the Park, a result of natural processes and deliberate protective measures (Michalik, 1989).

Additionally, changes in the area of plant communities and ecosystem types (forest, open-seminatural, open ploughed) were estimated on the basis of available literature.

Changes in species composition of the flora and fauna of ONP were documented in the abundant literature; in this paper we made use of the most important synthetic monographs and reviews (Dumnicka et al., 1990; Dylewska, 1990; Klasa, 1990; Michalik, 1974; Mielewczyk, 1990; Pawłowski et al., 1994; Razowski, 1995; Stworzewicz, 1990; Szczęsny, msc.; Szeptycki, 1990; Szyndlar, 1995; Tomek, 1995). The first plant and animal species lists were published at the beginning of the ninetieth century.

Comparison of the lists compiled in successive time periods provides fairly precise information on the withdrawal of particular species from the Park. The records of new forms are much less reliable, especially among the invertebrates. The number of new species in this group grows together with intensification of research (see Pawłowski et al., 1994). Among these new species there are both immigrants and the newly discovered taxa (previously neglected). In this situation, despite the copious data, the verified information about immigration (input) and extinction (output) refers only to the four most important ecological groups of vascular plants: (1) water-marshy species, (2) species of fresh meadows and mesophilous communities, (3) species of meadows and xerothermic brushwood and (4) species of forest communities. In the case of fauna the verified output and input data comprise all vertebrates (except for bats) and the selected, best known, invertebrate groups.

To illustrate the dynamics of changes in flora and fauna, two indices were introduced:

1. Balance index (BI) showing changes in the flora and fauna in relation to the total number of species in the investigated group:

$$BI = (N_I - N_R) / N_{TOT},$$

where N_I denotes the number of incomers, N_R – number of retreaters and N_{TOT} – total number of species in the investigated group.

2. Weighed Balanced Index (WBI) where the annual balance rate was calculated:

$$WBI = (N_I - N_R) / (N_{TOT} \cdot T),$$

where T denotes the period of observation of flora and fauna changes.

Results

Forms of human pressure within the area of ONP in the last 150 years and outside its boundaries

The area of ONP was under strong human impact for a very long time (for about some thousand years) (Partyka, 1990). As intensification of agriculture area occurred very slowly, a characteristic manner of utilization of particular ecosystems developed in this area, and remained almost unchanged until the end of the 19[th] century (Table 1).

On the turn of the 19[th] century Ojców became a well-known summer-resort for Kraków and Warszawa inhabitants. In that period many pensions were established and the first tourist facilities, such as tourist trails, restaurants, museums etc., were provided. After the

Table 1. Human induced environmental changes leading to the growth of isolation of the flora and fauna of ONP (changes outside the Park area)

Change	Effect	Duration	Author
Regression of floods (as an example of overall stabilization of environment, i.e. fires, floods, mass outbreaks etc.)	Lack or diminish of immigration of mountain species from the Carpathian source	Since the turn of thirties	Pawłowski et al., 1994
Roads and fences (as the examples of construction of barriers around the ONP)	Decrease of immigration rate of pedestrian animals	Particularly intensive changes began in seventies	Partyka, 1990
Growth of urban and village settlement areas	Decrease of immigration rate of plants and animals decrease of source populations	Particularly intensive changes began in sixties	Partyka, 1990
Pollution (air and water)	Various effects: isolation from outside sources, increase of extinction rate, particularly among water and marsh species, changes in composition of species in ONP	Just since the turn of fifties	Partyka, 1990 Gądek, 1990 Ząbecki, 1990
Large scale agriculture and use of chemicals (nutrients, herbicides and pesticides)	Decrease of source populations outside ONP, impact of chemicals through simple inflow to the ONP	Since sixties	Dąbrowski, 1990

national park was created, the previous forms of farming and forest management were gradually being abandoned, as well as the function of the site as a summer resort. Coppicing practices have almost completely been abandoned, a resort function neglected (decrease in a number of beds), cultivation of permanent meadows and pastures have ceased, technologies utilizing energy of falling water have been given up, a mass tourism, and especially week-end one, increased (Table 2). Open areas in the Park were being gradually overgrown with arboreous vegetation (Michalik, 1996) as a result of intense secondary succession and deliberate (though unreasonable) afforestation carried out by Park service (Table 1).

From the point of view of individual species conservation, landscape changes that occurred around the Park during the last five decades may be systematized as shown in Table 2. During the century we have observed the following macroscale phenomena:

- stabilization of the environment: construction of flood embankments prevents the extensive river floods; the fire brigade's system prevents spreading of natural and provoked fires etc. (Pawłowski et al., 1994)
- fragmentation of habitats through construction and widening of transport routes and development of large urban agglomerations (Partyka, 1990)
- isolation of the area of ONP through overbuilding and enclosing areas adjacent to its border (Partyka, 1990)
- gradual growth of air and water pollution. Pollution directly affects the ecosystems of ONP, bringing about the decline of particular plant and animal species, and changes in the trophic structure and composition of species in particular ecosystems (Szyndlar, 1995; Gądek, 1990; Szczęsny, 1997; Ząbecki, 1990).

Table. 2. Human induced changes within the area of the ONP during last 150 years (based on Michalik, 1974, 1990)

Human impact	Effects	Duration
Decrease of pasturage	Decrease of landscape diversity, decrease of fraction of open habitats, decrease of number of plant communities, decrease of number of species, increase of extinction rate	Since late fifties
Vanishing of coppicing practices		Since early fifties
Vanishing of resort function		Since the turn of thirties
Decrease of water utilization for local industry		Since the turn of thirties
Decrease of mowing		Since the late sixties
Increase of weekend tourism		Since the early sixties
Increase of artificial afforestation		1950-1970
Decrease of economic forestry		Since the late fifties

The effect of man's interference on plant communities, flora and fauna of ONP

Plant communities

Changes occurring in the nature of ONP are synthetically shown on phytosociological maps. The long-ago pristine state (assuming no man's interference in the site) is presented on the map of potential vegetation (Fig. 2c). The potential vegetation is clearly less diversified that the contemporary vegetation; all communities connected with man's husbandry are lacking. Historical documentation (written sources, drawings, photographs etc.) shows that at the beginning of the 19th century the oligothermic, shade-loving and higrophilous habitats (mostly forest ecosystems) covered about 70% of the present area of ONP (Michalik, 1996). In the 19th century and until mid of the 20th century those habitats were seriously reduced and at the moment of Park creation they occupied no more than 15-20% of its area (Michalik, 1990). The first map of contemporary plant communities of ONP (Fig. 2a) is dated from that period (Medwecka-Kornaś, Kornaś, 1963).

Changes in composition of the plant associations of ONP due to intensifying spontaneous succession and deliberate afforestation carried out in the period of protecting the area as a national park, are shown on the map of the contemporary vegetation produced at the turn of the eighties (Fig. 2b) (Michalik, 1989).

Comparison of the first map with the remaining two shows man-made transformations of the area. Comparing the two other maps we see alterations (induced mostly by secondary succession) that occurred during over 30 years of protecting the site as a national park.

Inventory of the state and changes in particular plant and animal groups

Vascular plants (ecological groups)

At the moment of creation of the ONP the vascular flora of the site numbered about 1000 species (Michalik, 1974). Now it totals about 960 species (Michalik, 1996). During 150 years (1850-1959 and 1960-1996) of studies and observations of the vegetation of Ojców

Table 3. Flora and fauna changes during last 150 years within the Ojców region

Fauna or flora	Max species number	Number of extinct species before ONP establishing	Number of extinct species after ONP establishing	Number of immigrants before ONP establishing	Number of immigrants after ONP establishing	Extinction rate before ONP establishing	Extinction rate after ONP establishing	Immigration rate before ONP establishing	Immigration rate after ONP establishing
Fauna									
Terrestrial mammals	40	3	0	1	3	0.026087	0	0.008696	0.085714
Birds	113	3	9	0	8	0.026087	0.257143	0	0.228571
Amphibians	10	0	3	0	3	0	0.085714	0	0.085714
Dragonflies	16	8	0	0	6	0.069565	0	0	0.171429
Carabids	169	15	6	0	0	0.130435	0.171429	0	0
Butterflies	92	0	8	0	2	0	0.228571	0	0.057143
Terrestrial snails	101	1	2	0	0	0.008696	0.057143	0	0
Flora									
Marsh species	100	16	17	0	0	0.142857	0.485714	0	0
Mezofile species	540	7	8	28	8	0.0625	0.228571	0.25	0.228571
Xerothermic species	146	4	22	2	0	0.035714	0.628571	0.017857	0
Forest and oligothermic species	214	9	8	2	3	0.080357	0.228571	0.017857	0.085714
Mean		6	7.54	3	3	0.05	0.22	0.03	0.09

and its environs, 91 retreaters and 43 incomers were found (older data were confined to the present area of ONP) (Table 3). Among the retreaters most numerous were species characteristic of water, marshy and wet habitats (33). Least was the loss of species typical of open meadows and mesophilous pastures (15). Among the incomers, there were as much as 36 new species characteristic of mesophilous meadows and pastures were noted and no species of water, marshy and wet biotopes.

An analysis of the flora change's balance (BI = balance index) over the whole period (Fig. 3) shows that during the 150 years of studies meadow species have increased in number. A slight decrease was noted in forest and shade-loving oligothermic species and a more pronounced, among species confined to chalk grassland habitats. Water and marshy species suffered the greatest loss. Analyzing the same changes (WBI = weighed balance index) in the periods before (1850-1959) and after (1960-1996) the creation of ONP, we have found (Fig. 4) that the species of meadows and pastures was increased in number before the Park was established. Other groups of species suffered losses both

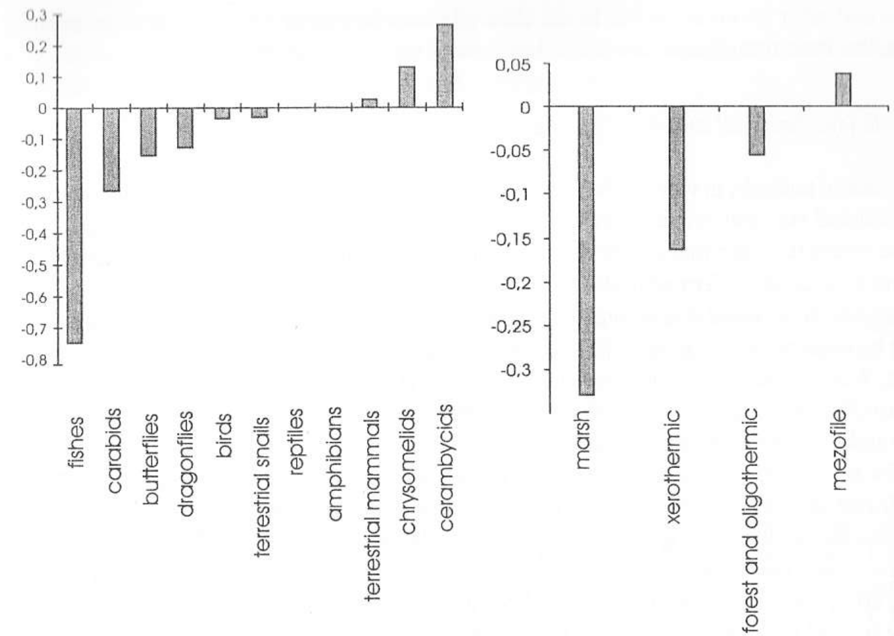

Fig. 3. Total changes (loss and income) in selected group of flora and fauna of the ONP during 150 years of observations.

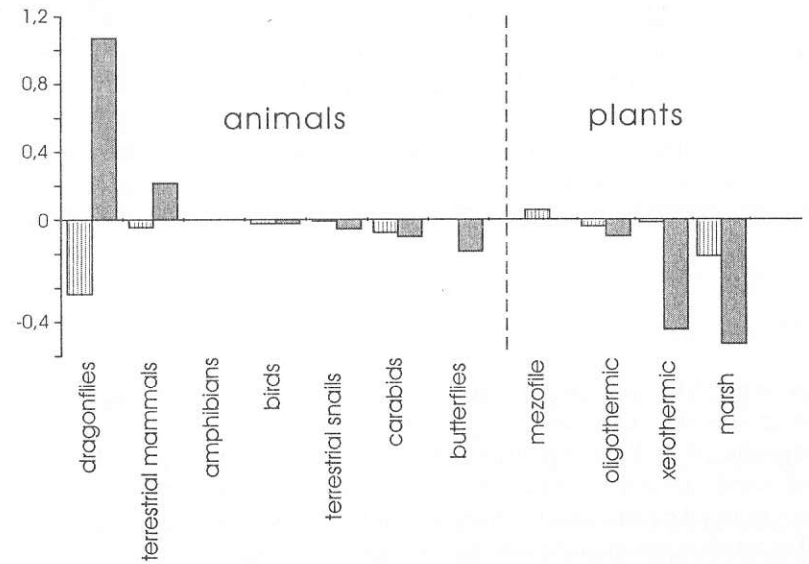

Fig. 4. Weighed changes (loss and income per species and per year) in selected group of flora and fauna before and after establishment of the ONP.

before and after its creation but in the case of xerothermic, as well as water and marshy plants, the Park foundation accelerated the rate of species extinction.

Animals (systematical and ecological groups)

In the case of animals, in view of the total number of species (over 5500 known so far) and their differentiated size and mobility, as well as the less precise documentation of changes, fairly precise estimates were made only for vertebrates (except for bats), dragonflies, some beetle families (*Carabidae*, *Cerambycidae*, *Chrysomelidae*), butterflies and terrestrial snails (Table 3). It should be stressed that a considerable number of animal species was deliberately introduced by man into the area of ONP. The introduced species comprise the beaver (*Mammalia*) (Klasa, Wisniowski, 1996), the salamander (*Amphibia*) (Szyndlar, 1995), the rainbow trout and the carp (*Pisces*) (Szczęsny, 1997), the two butterfly species: *Maculinea arion* (Woyciechowski, 1991) and *Zygaena carniolica* (Dąbrowski, 1990), which once became extinct in the Park.

Fifty six mammal species, 113 breeding bird species, 5 reptile species, 10 amphibian and 20 fish species have so far been recorded in the Park. Numbers of invertebrate species in particular systematical groups were given by Pawłowski (1997) and Szczęsny (1997). However, they mentioned that many systematical groups were unsatisfactorily known.

We compared indices BI (balance index) and WBI (weighed balance index) calculated for the better known systematical groups. The first of them shows an increase in number of *Chrysomelidae* (living mostly in open habitats, mesophilous meadows and pastures) and *Cerambycidae* (living almost exclusively in forest habitat), and a slight increase in number of terrestrial mammals in the Park over the last 150 years. The numbers of amphibian and reptile species has not changed, while terrestrial snails, dragonflies, butterflies (*Rhopalocera*), carabid beetles and fishes suffered losses (Fig. 3). Comparison of changes occurring in particular animal groups in the periods before (1850-1959) and after (1960-1996) the creation of ONP shows that the rate of species extinction was quicker before the Park was established (dragon-flies and terrestrial mammals), or it did not changed (amphibians and reptiles). After the site was taken under protection, extinction processes intensified only slightly in a few systematical groups (terrestrial snails, carabid beetles, butterflies and fishes).

Conclusions

1. The isolation of ONP is gradually increasing, however, the effect of growing isolation on particular groups of species varies greatly (Table 1).
2. The ecosystems of ONP underwent and undergo strong transformations; the group of water and marshy species suffered losses before and after the creation of the Park.
3. Transformations take place despite protection of the site as a national park, which was believed to stabilize the environment and the impact of man.
4. As a result of growing isolation, human impact, environmental changes and inappropriate protective measures we observe the gradual biodiversity erosion:

- a decrease in the total number of species (Table 3)
- a decrease in the number of species connected with rare and strongly transformed habitats
- a lack of balance between extinction and immigration
- an increasing threat to many systematical and ecological groups, as well as particular species.

Assumptions for biodiversity conservation

The collected inventory data and the above conclusions allowed to formulate the programme of biodiversity and vital population's conservation in ONP, based on the following considerations:

Biodiversity conservation

According to island biogeography theory, the number of species (S) in a given area is function of immigration (I) and extinction (E) rates. Changes in I or E rates affect the total number of species in the area. In the ONP case the observed growth of isolation causes that I_t is surely smaller than I_O (where I_O denotes immigration rate ca 150 years ago). In this situation even if $E_t \sim E_O$ then $S_t < S_O$. Otherwise, because $(I_O/E_O) > (I_t/E_t)$ then $S_t<S_O$.

To maintain in the future the same number of species as now exists ($S_{t+n} \sim S_t$), in view of the assumed maximization of biodiversity (maintenance of the present S value) and no chances of making migration into the Park more intensive, we should endeavor to decrease extinction rate of species living in ONP ($E_{t+n} < E_t$). This should lead to stabilization of species number (though not of species composition) in the Park.

Viable populations conservation

The theory suggests that to maintain viable metapopulations of threatened and disappearing species we ought:

- to maximize size of at least some patches (A_p), where A_p denotes the area (size) of the patch
- to maximize number of inhabitable patches (P_{TOT})
- to maintain ratio $p_i/p_e > 1$ (where p_i is probability of empty patch occupation, while p_e is probability of extinction of already occupied ones).

To maintain viable populations of rare species of scattered distribution in the Park two measures were proposed:

In the case of larger (source) populations activities aimed at stabilization of their habitat were undertaken to maintain maximum densities.

In the case of small patches (occupied and empty) a distance between patches were minimized to increase ratio $p_i/p_e > 1$. To maintain small local patches (smaller than source ones) the following activities were undertaken:

- Smaintaining a considerable number of patches (occupied and unoccupied)
- maintaining a constant fraction of occupied patches
- reducing probability of extinction of occupied patches
- reducing a distance (isolation) between patches.

Conservation as viewed at a landscape scale

Maintaining artificial overdiversity of habitats and semi-natural ecosystems as a method of hot spot biodiversity conservation in ONP

To attain this goal it is necessary:

- to maintain a mosaic of semi-natural habitats and arable land, in proportion no less than 1/3 of the total protected area in ONP (Fig. 2b)
- to create biodiversity centers:
- forest biodiversity centers for conservation of cold-loving species, mountain and boreal-mountain relics in flora and fauna (on the country scale they are mostly sink populations, on the ONP scale they may be classified as larger, local source, and smaller, local sink populations)
- chalk grassland biodiversity centers for conservation of thermophilous relic species in flora and fauna of ONP (on the country scale the chalk grassland habitats of ONP play an important role as sources, locally they are divided into groups from source to sink, depending on the state of preservation)
- to maintain fresh and wet meadow communities
- to restitute water and wet communities.

Creating 'species packing corridor's to maintain unrestrained migration of species between sources

These corridors should be specially designed to maximize number of species which may occupy them.

"Species packing corridors" idea

Michalik (1992) has found that the number of species in ONP ravines depends on slope aspect and manner of utilization (Fig. 5). In the case of ravines of NS (and similarly) exposed walls, various forms of management on northern and southern slopes result in various numbers of developed plant communities and various total species numbers on the cross-section of ravine. Of three variants: (1) both slopes forested, (2) only N slope forested, and (3) only S slope forested, the third appeared most favourable. Such a way of slope management resulted in the greatest total number of plant communities, the greatest total number of species, and the greatest number of species representing so-called 'extreme' habitats (oligothermic versus xerothermic) on the cross-section of a slope.

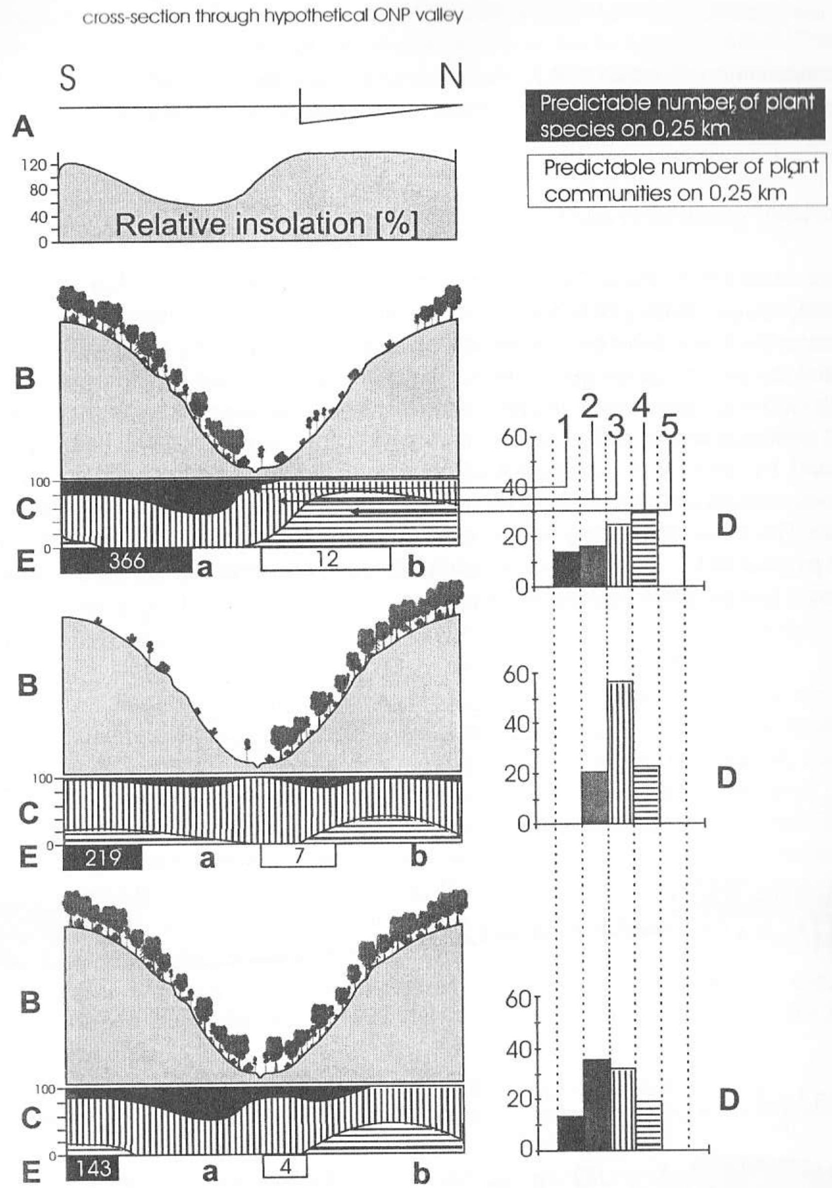

Fig. 5. "Species packing corridors" (diversity conservation). A cross-section through hypothetical ONP valley. A – relative insolation, B – plant cover (open versus afforested slopes) C – percentage distribution of oligothermic, mesophilous and xerothermic species in the cross-section, D – percentage of five ecological groups of species: 1 – strongly oligothermic, 2 – temperate oligothermic, 3 – mesophilous, 4 – temperate xerothermic, 5 – strongly xerothermic , E – total number of species (a) and number of plant associations (b) (after Michalik, 1992).

Creation of packing corridors

The conservation plan for ONP foresees that all ravines and valleys directed W-E (N and S slope aspects) will be managed according to Michalik's idea (1992), i.e. S slopes should be afforested and N deforested.

Mechanisms of corridors and stepping stones conservation

Between source populations (this concerns only xerothermic habitats), within 'species packing corridors', temporary habitats should be prepared to make migration of thermophilous species easier. These habitats were named 'walking sources' (Fig. 6). Such walking sources are patches open in a given place and at a given sequence, beginning from source population. In this way populations of the same species move towards each other from main sources (if the species occurs in both sources), and the direction of migration will be forced on the one hand, by opening of particular walking sources and on the other hand, by closing of previous sources, resulting from overgrowing with bushes in the course of secondary succession. This combination may be improved through magnifying or reducing size of established patches and, if need be, their division into fragments opened at successive phases of clearing a community from trees and shrubs.

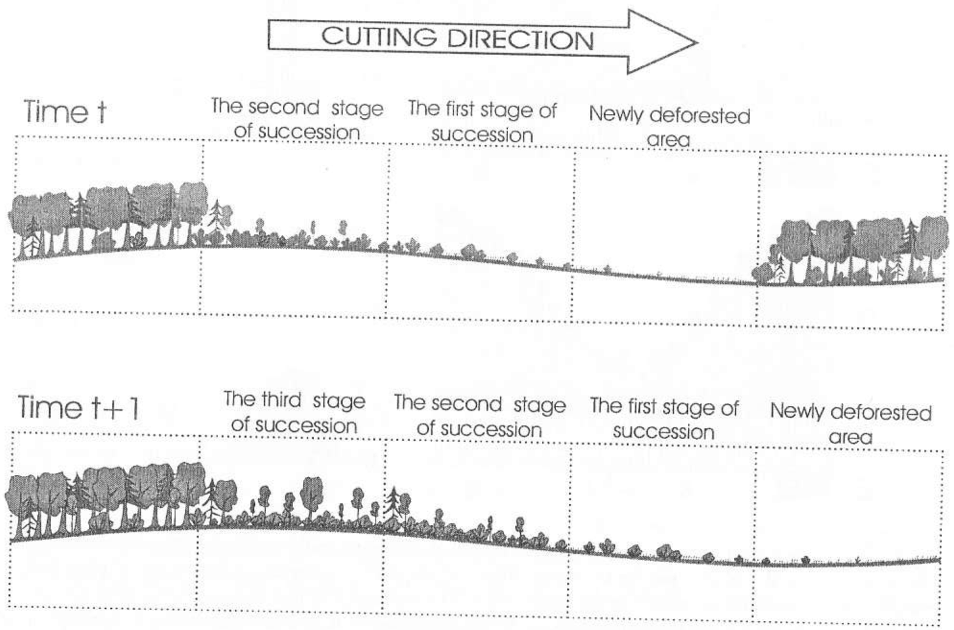

Fig. 6. Walking sources (population conservation) in the case of xerothermic flora and fauna.

On the assumption that the maximum span of time between successive clearings is 5 years, the maximum number of patches cut out from both sources can be no more than 8. Then the local 'walking sources' are opened successively from both directions. The calculated 'turn-over time' for particular patches (time till the successive clearing) within a 'walking source' is 5-3-3-5-3-3-5 years).

Discussion

In respect of vegetation diversity the area of ONP is a typical Central European protected site where from about a half to two thirds of biodiversity is attributable to human activity (Plachter, 1996). Due to considerable diversity of habitats and man-made transformations that small area has exceptional species richness – about 1000 vascular plant species (Michalik, 1990, 1992) and over 5500 identified so far animal species (Witkowski, 1997). That is why the site holds so high protective rank in Poland.

The specific problems of European nature conservation lie in that mosaic of ecosystems in a landscape and gradual intensification of forest and agricultural management practices (natural, semi-natural, and artificial plantations), continued nearly to the fifties of our century. Many related publications show that in Europe there is a general awareness that semi-natural and man-made ecosystems have a great natural value and should be effectively protected (Duffey, Watt, 1971; Hillier et al., 1989; Spellenberg et al., 1989).

Due to considerable fragmentation of arable land and underinvestment, the methods of farming in southeastern Poland are still extensive. In the recent years this situation has quickly been changed and protected sites, strengthened so far by immigration from the large pool of surrounding them semi-natural agrocoenoses, suffer increasing isolation. Moreover, small patches of meadows, pastures, and chalk grasslands in the ONP are being overgrown and impoverished in characteristic species because inappropriate methods of their protection were applied in the past (Michalik, 1992; Dąbrowski, 1990).

In the ONP case two ways of maintaining high biodiversity are possible: increasing the immigration rates or decrease the autochthonous species extinction. As the first way can not be used (see Table 1), we propose measures aimed to stop the loss of local species to lower the rate of local species extinction so as to maintain the local hot spot. In the spatial context this means:

1. Maintaining considerable diversity of ecosystems.
2. Maintaining local source habitats and source populations (with long term probability of persistence and high net reproduction rate ($r>>1$) (Pulliam, 1988).
3. Creating 'species packing corridors' valleys with the highest possible number of occupying them species and the highest possible number of plant associations (Michalik, 1992).
4. Special management of xerothermic habitats in 'species packing corridors' to maintain 'walking sources', i.e. sequential clear-cutting of xerothermic grasslands (Witkowski, 1982).

This strategy is one of many variations of semi-natural ecosystem management, proposed in Europe. Webb, Thomas (1994) suggested rotational clear cutting of heathlands to minimize the distance between the warmest habitats to maintain viable butterfly populations. Similar, but simpler rotation of meadow management were suggested by Kudrna, Kraliček (1991) and Zarzycki et al. (1989) to maintain invertebrates and plants, and Morris (1989) proposed several management techniques to maintain open habitats in protected chalk grasslands.

Our suggestions have one weak point – we did not evaluate the area requirements of viable populations of threatened plant and animal species but we believe that each increase of habitat patch occupied by threatened species if do not stop then at least considerably decreases probability of their extinction.

Translated by the authors

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Witkowski Z.J., Michalik S., Adamski P.: **Ochrana okrajových území v chránených oblastiach: prípadová štúdia Národného parku Ojców.**

Na základe štúdia literatúry zaoberajúcej sa flórou a faunou Národného parku Ojców možno rekonštruovať zmeny za posledných 150 rokov. Ľudskou činnosťou sa zvýšil počet a diverzita ekosystémov (rastlinných spoločenstiev). Faktom, že toto stanovište sa stalo chráneným, znížila sa priestorová diferenciácia a počet ekosystémov, hlavne poloprírodných kriedových lúk a polootvorených krovinných habitatov, čo vo flóre a faune zapríčinilo veľké zmeny. Významný pokles sme zaznamenali v počte druhov bažinných a xerotermných stanovíšť a mierny pokles v tieňomilných a oligotermných druhov. V posledných rokoch sa zvýšil počet druhov iba na lúkach a pasienkoch. Krajinárske a environmentálne zmeny sa uskutočnili okolo a vo vnútri Národného parku Ojców a viedli k zvyšujúcej sa izolácii miestnej prírody a k tendencii vyhynutia autochtónnych druhov. Mieru imigrácie druhov do Parku nemožno ovplyvňovať tak, ako predpokladali autori, že ochranné práce by mali znížiť mieru vyhynutia druhov v území.

Autori navrhujú:

- udržať značnú diverzitu ekosystému v Parku so zvláštnym zreteľom na poloprírodné ekosystémy
- vytvoriť a udržať miestne stanovištia podporujúce populácie
- vytvoriť koridory na "zachytávanie druhov"
- vytvoriť tzv. prechádzkové miesta pre druhy ekosystémov kriedových lúk v rámci koridoru.

ECOLOGICAL PARAMETERS OF OAK AND OAK-HORNBEAM FORESTS IN THE LUČENECKÁ KOTLINA BASIN

HUBERT ŽARNOVIČAN

Gymnázium B.S. Timravy, Haličská 9, 98401Lučenec, The Slovak Republic

Abstract

Žarnovičan H.: Ecological parameters of oak and oak-hornbeam forests in the Lučenecká kotlina basin. Ekológia (Bratislava), Vol. 23, No. 1, 57-64, 2004.

This paper deals with ecological characteristics of oak and oak-hornbeam forests in selected areas of the Lučenecká kotlina basin. It gives more exact information on requirements of such communities for ecological factors of the environment in sense of Ellenberg's opinions (Ellenberg, 1974). The relations estimated between individual vascular plants and soil reaction using ecological values of Ellenberg seem to the most interesting ones. These results show that the association *Genisto pilosae-Quercetum* has the highest number of acidophilous or extremely acidophilous species. Moreover, it well suits to syncecological characteristics of this phytocoenose, which is typical for its affinity to podzols. Associations *Querco petraeae-Carpinetum* and *Aceri tatarici-Quercetum* are typical for the occurrence of slightly acidophilous species.

Introduction

A phytocoenological work on basin oak forests from the alliance *Aceri tatarici-Quercion* Jakucs et Fekete 1957, Zólyomi 1957 and oak-hornbeam forests from the alliance *Carpinion betuli* Issler 1931 em Meyer 1937 was created in 1999-2001. The phytocoenoses of acidophilous oak forests from the alliance *Genisto germanicae-Quercion* Neuhäusl et Neuhäuslová-Novotná 1967 were described. As for the first alliance, the association *Aceri tatarici-Quercetum* Zólyomi 1957 was syntaxonomically defined. It has relatively rich characteristic species combination (constant and characteristic species) which accounts relatively abundant *Acer tataricum* in the shrub as well herb layer, then *Swida sanguinea, Ligustrum vulgare, Euonymus europaeus, Brachypodium pinnatum, Melica uniflora, Cruciata glabra, Stellaria holostea, Fragaria vesca, Pulmonaria obscura, Viola hirta, Viola reichenbachiana. Quercus cerris* dominates in the tree layer of this association, *Q. dalechampii* is less abundant and *Carpinus betulus* is only sporadically admixed. Ac-