

## INFLUENCE OF RECREATION IMPACT ON FOREST ECOSYSTEMS STABILITY AND THEIR BIODIVERSITY: THE CASE OF THE SHATSK NATIONAL NATURAL PARK

Natalia Pits, Igor Gorban, Olga Alokchina

The Karpenko Physico-Mechanical Institute, National Academy of Science of Ukraine  
Naukova str. 5, 79053, Lviv, Ukraine  
nataliapits2007@yandex.ru, ihorban@yahoo.com, alokhina@ipm.lviv.ua

**Summary.** The Shatsk National Natural Park is located in the western part of Polesie region within the basins of the Prypyat and Bug rivers in Ukraine near the borders of the Poland and Belorussia. Recreation nature employment within the Shatsk National Natural Park (SNNP) territory is concentrated near such lakes as Svityaz' and PISOCHNE, which are partially surrounded by forest. Insular effect of recreation was created, as a result of increasing anthropogenic loads on all these ecosystems areas that, in turn, form four recreation zones. Anthropogenic load on these areas exceeds a stability limit of ecosystems to recreation load. It's defined that the higher stability to recreation load has dry and very dry habitats. Dry and wet habitats (C1–C2 conditions), which have sufficiently rich biological diversity, are the most attractive for recreants. Stability limit of forests to recreational load in Shatsk NNP conditions locates between wet and damp conditions. Development and spreading on new areas of the fourth stage of recreation impact to extinction of forest animal species from this area. The fourth stage of recreation further the process of local fauna synanthropication in the Shatsk NNP territory. These changes of natural environment must be a signal for immediate development of the protection plan of the Shatsk NNP nature.

**Key words:** Shatsk National Natural Park, forest ecosystems, recreation impact, ecosystem degradation, biological diversity

### INTRODUCTION

During last two decades, our investigations, mainly, concern the Shatsk National Natural Park (SNNP) territory, which, in our days, is intensively used in recreation targets. According to the functional zoning of the park's territory, the processes, which cause ecosystem degradation, were detected in the park's recreation zones. Recreation impact was provoked by the influence of anthropogenic factors that leads to soil compaction, trampling down the forest floor and some grass cover areas, underbrush eliminating as well as trees harming.

Table 1. Indexes of recreational loads, which define one or another stages of forest degradation by tourist traffic

Stages of forest degradation by tourism traffic	Classes of forest resistance in tourist traffic to recreational loads (person per day/ha)				
	1	2	3	4	5
1	1.5	1.0	0.6	0.3	0.1
	0–3.0	0–2.0	0–1.2	0–0.7	0–0.3
2	4.5	3.0	1.8	1.0	0.5
	3.0–6.0	2.0–4.0	1.2–2.5	0.7–1.4	0.3–0.7
3	11.9	8.0	5.0	2.9	0.5
	6.0–17.8	4.0–12.0	2.5–7.5	1.4–4.4	0.3–0.7
4	26.6	17.9	11.2	6.5	3.1
	17.8–35.5	12.0–23.8	7.5–15.0	4.4–8.7	2.1–4.2
5	47.1	31.7	20.0	11.5	5.5
	35.5–58.8	23.8–39.6	15.0–25.0	8.7–14.4	4.2–6.8

At present time, we can mark out different number of recreation stages: from three to five [Methodological recommendations 2003]. For forest natural complexes, five stages of recreation impact are grounded, which depend on recreation coefficient, forest state, underbrush, grass and moss covers and forest floor character (Tab. 1). E. Repshans considers a five stage differentiation of degraded forests as labour-intensive and, in turn, he proposes to mark out only three stages [Repshans 1981]. Another methodology, proposed by A. Direnkov is grounded on marking out of four stages [Direnkov 1983]. Such parameters as soil compaction coefficient ( $C_{sc}$ ), forest floor, stand of trees and underbrush stability to recreation loads are recognized as main diagnosis factors of forest biogeocoenosis degradation [Polyakova 1979].

#### RESEARCH AREA, MATERIALS AND METHODS

The most popular recreation within the Shatsk NNP, first of all, is connected with such lakes as Svitaz' and PISOCHNE (Fig. 1). The last one belongs to forest lakes and on its shores different preventoriums and encampment are located. Near PISOCHNE Lake, recreation processes are developed for a last 40 years and their influence is especially perceptible for surrounded forest massifs. Our investigations, which are connected with studying of recreation traffic influence on forest ecosystems and their biodiversity state, were organized, namely, in the recreation zone of the Shatsk NNP near the shores of above-mentioned lakes. Usage of forest-covered areas for mass recreation, first of all, is connected with tours, outings, youth sport games, mushrooms and berries gathering etc. Only some elements of natural complex or their components, in spite of relatively small quantity of recreants, are sensitive to such visiting's.

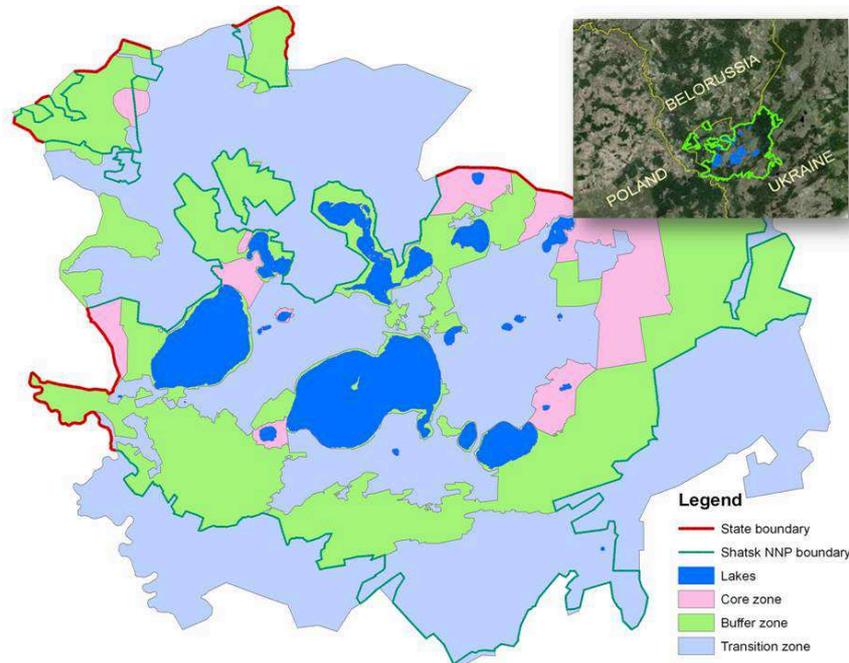


Fig. 1. Landscape of the Shatsk National Natural Park

The speed and character of the degradation process depend on the external influence intensity that can be expressed in recreational load (amount of persons per unit of area and per unit of time).

The result of the anthropogenic influence depends on the internal properties of defined natural complex, in other words, from the relief, weather conditions, soil type, soil conditions during the recreation period, vegetation cover composition and other factors [Sorokina 2003]. Since, in most cases, the results of recreation influence on natural complexes is determined in vegetation cover changes, so factor is expressed by stages of phytocenosis changes.

At the beginning of the process, in the case of insignificant influence of recreants, changes could be visible only on biotic components: vegetation and animal world. These changes could be considered as renewal, because, if the influence will be stopped, the natural complex will return to the initial stage. In other words, the process of self-restoration will begin and it is called the digression reversion. At this stage, the process of natural complex is considered as restored [Shelyag-Sosonko *et al.* 1981, Getman 2000].

The next stage will begin if the natural-territorial complex physiocoenose [Andrzejewski 1983, Chmielewski 1992, 2012] changes will exceed a stability threshold. This stage characterizes by the absence of young underbrush and, in further, changes of such components as soil, water and air (components of geomatic group). The essence of the process consists in change of natural-complex in whole as a result of evolutionary accumulation of changes as its biota so

the geomatic environment. As the result of above-mentioned process, up to IV stage of degradation, the natural complex (ecosystem) undergo changes at which phytocenosis loses the ability of forest restoration [Grynevetsky 2004].

## RESULTS

The map of recreation impact to forest ecosystems around the PISOCHNE Lake is shown in the Figure 2. Estimation of the forest degradation degree was performed here using five-point scale (Tab. 1) [Noga *et al.* 2004].

In columns 1–5 there are average calculation data ( in numerator) and min-max deviations from the rate of tourist impact to different stability classes of forest (in denominator).

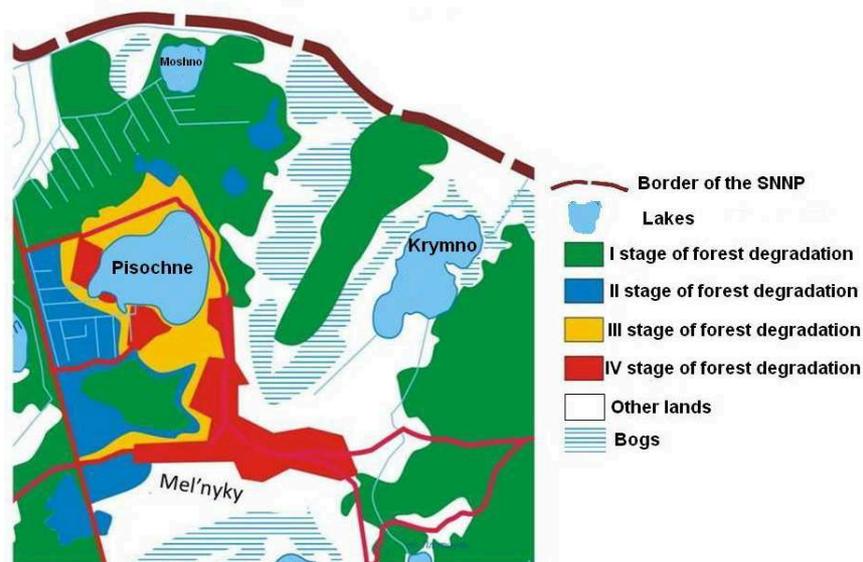


Fig. 2. Map of recreation impact to forest ecosystems around the PISOCHNE Lake

The present (2012) state of recreation impact that occurs around the PISOCHNE Lake in the Shatsk NNP during last decade is shown in Figure 2. Expansion and seizure of the fourth stage of impact on a new areas lead to wild animal species extruding from this locality, but – in turn – assists of new species penetration, which are not typical to forest ecosystems. Thereby, the fourth stage of recreation impact, which corresponds to anthropogenic loads in the nearest Melnyky village, furthers the sinanthropication process of local fauna within the Shatsk NNP territory. As the result of the third stage of recreational impact, round the PISOCHNE Lakes territory, the following sinanthropic and half-sinanthropic species were penetrated as: White Stork (*Ciconia ciconia*), Swallow (*Hirundo rustica*), House Martin (*Delichon urbica*), Pied Wagtail (*Motacilla*

*alba*). But then such bird species as Tawny Owl (*Strix aluco*), Black-headed Gull (*Larus ridibundus*) and Woodpigeon (*Columba palumbus*) began to adapt to anthropogenic landscape and its derivative territorial complexes. Aftereffects of such sinanthropication process of the Shatsk NNP fauna, are needed to be investigated in details [Gorban 2002, Tsaryk *et al.* 2002].

Table 2. State of forest ecosystem in different stages of degradation

Stages of forest ecosystem degradation	State of forest ecosystem
I	Undisturbed, elastic forest floor; full vegetation species composition; numerous underbrush of different ages
Biogeocoenosis (ecosystem) stability limit	
II	Pathways appears (to 5% of area); trampling down the forest floor; penetration of forest ecotone species into the forest
III	10–15% of trampled down areas; lesser capacity of forest floor; sparse plants cover; decreased amount of underbrush; increased amount of meadow and weed plants species
The maximum permissible recreational load	
IV	15–30% of trampled down areas; the forest floor is absent on glades; sparse plants cover; low viability of underbrush
Critical limit of biogeocoenosis (ecosystem) restoration possibility	

In recreational geography, within the biogeocoenosis direction, phytocenosis considers as the main factor of natural complexes stability changes. At the landscape approach, geomatic factors are considered as main but, at that, a partially role belongs to biotic factors also.

The character of main soil types influence on natural complexes stability through their density, structure and rigidity. Natural complexes, which have soils of light mechanical composition (sand, loamy sand), at trampling down, will change their initial properties (mainly, soil properties and biocoenosis character) faster than natural complexes with soils of heavy mechanical composition (clay soil). In accordance with above-mentioned, the first have lower stability to recreational impact. Touching the wetting level, the natural complexes, which have impact water conditions, namely, damp and wet, are characterized by the highest stability degree. During humidity fluctuations, a stability of natural complexes is decreasing. Such process appears as a result of worsening of water and air regimes for plants and soils, accordingly. Such changes lead to changes in vegetation cover and further penetration the fauna species, which were not characteristic for these territories before recreation process beginning. Among the birds, who penetrate into the forest ecosystems after recreation beginning, Blackbirds and Fieldfare can be marked. They can found their food only on the ground and exactly on areas without forest cover. It is known that on the total recreational territories of the Shatsk NNP, the forest floor is removed and therefore the above-mentioned process further the penetration and nesting of new bird species, which obtain a favorable conditions for feeding and reproduction.

Diagram of stages of forest ecosystem degradation by tourist traffic is shown in Figure 3. The first stage presents the highest natural capacity for recreants, in other words, the highest stability have dry and very dry dubravas and the most attractive conditions for recreants have dry and fresh sudubravas (C1–C2 conditions). Stability limit of forests is located on the border between damp and wet conditions, so damp pine forests and wet sudubravas (B4–B5 conditions) have the most propitious influence.

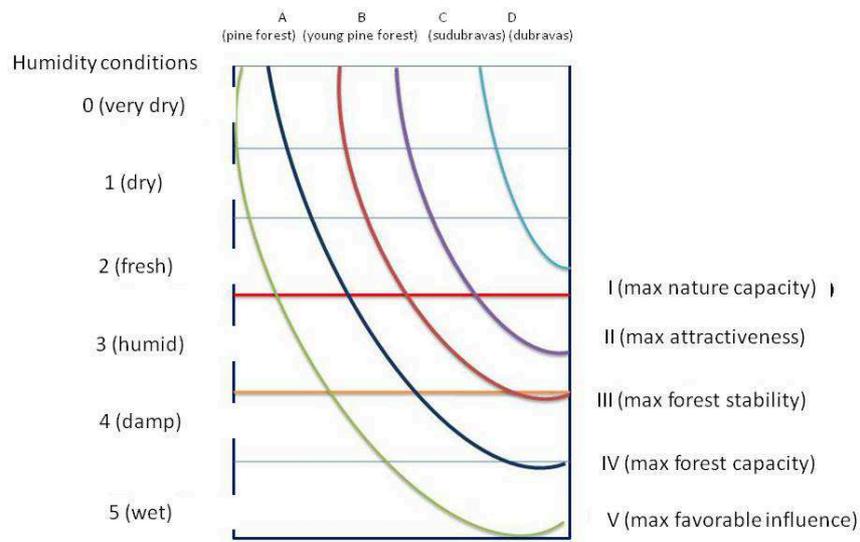


Fig. 3. Diagram of ecosystem degradation stages in the recreation forest

It is necessary to indicate that there is no a single opinion, among the authors, concerning of which stage of the impact row consider as critical for the forest state. After the second stage of the impact, the irreversible process of forest ecosystem degradation can be observed [Kazanskaya 1972, Miller *et al.* 2002]. In our opinion, exactly this methodology is optimal for studying and estimation of state of recreational nature-protected forests with pine predominance.

## CONCLUSIONS

It was determined that in forest ecosystems, in the first stage of recreational impact, first of all, mammals and some amphibian species disappear. Concerning the birds, especially sensitive species to the unrest factor during the reproductive period disappear. First of all, there are rare species with the high nature-protected status and wild bird species. Because of the degradation process, the following non

– forest species begin to penetrate to forest ecosystems – Jackdaw (*Corvus monedula*), Black Redstart (*Phoenicurus ochruros*), Fieldfare (*Turdus pilaris*), Tree Sparrow (*Passer montanus*). Buildings network and different recreational grounds within the peripheral part of forest ecosystem lead to spine and spineless animals penetration, which are characteristic for anthropogenic landscapes. As the result of such process and because of the recreational impact to forest ecosystems, the intensification of processes of a row of animals' sinanthropication occurs, that is especially appreciable on birds fauna of the Shatsk NNP. Here, on recreational territories of the forest fund, sinanthropic settlements of such species as Starling (*Sturnus vulgaris*), Great Tit (*Parus major*), Greenfinch (*Chloris chloris*), Goldfinch (*Carduelis carduelis*) and Linnet (*Acanthis cannabina*) are formed.

The modern recreation nature employment in the Shatsk NNP territory is concentrated near the main aquatic complexes – Svityaz and Pisohne Lakes. It creates a peculiar insular effect and forms a four recreation zones, in which loads exceeds a stability limit of ecosystem to recreational load. Detection of numerous areas with V and IV stages of recreational digression within the existent recreation zones is the evidence of above-mentioned. Therefore, in present conditions of the increasing development of recreation potential on natural ecosystems, it is necessary to begin a preparation of a nature conservation and spatial management plan. It must concerns the problems connected with the interests of the national park development as well as it populace and recreants. Preparation of such plan should include the problems of biological diversity conservation, especially such flora and fauna species, which contribute to the Shatsk NNP creation.

#### REFERENCES

- Andrzejewski R., 1983. W poszukiwaniu teorii fizjocenozy. Wiad. Ekol. 29, 2, 93–125.
- Chmielewski T.J., 1992. Próba modelowania funkcjonowania fizjocenozy jako dynamicznego układu poliekosystemowego, w: T.J. Chmielewski, A. Richling, K. Wojciechowski (red.), Funkcjonowanie i waloryzacja krajobrazu. Polskie Towarzystwo Geograficzne, Lubelskie Towarzystwo Naukowe, Towarzystwo Wolnej Wszechnicy Polskiej, Lublin, s. 25–38.
- Chmielewski T.J. 2012. Systemy krajobrazowe: struktura, funkcjonowanie, planowanie. Wydawnictwo Naukowe PWN Warszawa, 408 ss.
- Dyrenkov A., 1983. Changes of forest biocoenosis under the influence of recreation loads and opportunities of their regulation (in Ukrainian). M.: Nauka, 20–34.
- Getman V., 2000. Concepts of ecological tourism in the normative-legal context of biological and landscape diversity conservation of the recreation nature-protected territories. Ukraine and global processes: geographic dimension (in Ukrainian). Luck, 1, 356–359.
- Gorban I., 2002. Rare bird's species of the Shatsk National Park (in Ukrainian). Herald of the Lviv University. S: Biology, 29, 188–199.
- GrynevetskyV., 2004. Nature-protection landscape science: scientific basis, needs, and premises of development in Ukraine (in Ukrainian). Ukrain. Geogr. J., 3, 44–50.
- Kazanskaya N., 1972. Studying of recreational digression of natural vegetation associations (in Russian). S: Geography, 1, 52–59.

- Methodological recommendations concerning determination of a maximum recreational load on natural complexes and objects within the nature-protected fund of Ukraine according to zonal-regional distribution (in Ukrainian). Government Service of the Protection Affairs of the Ministry of Ecology and Resources of Ukraine. Kyiv, 43 pp.
- Miller G., Petlin V., Melnyk A., 2002. Landscape Science: theory and practice (in Ukrainian). A tutorial of the I. Franko Lviv National University, 172 pp.
- Noga I., Shatalov V., Kornilova N., Rasin Y., 2004. Acceptable recreational load on the linear routes in objects of the nature-protected fund of Ukraine (in Ukrainian). Herald of the Donetsk Institute of Tourist Business, 8, 227–232.
- Polyakova G., 1979. Recreation and degradation of forest biogeocoenosis (in Ukrainian). Forest Economy, 3, 70–80.
- Repshans E., 1981. Definition of state and recreation capacity of recreation forests (Methodological recommendations) (in Ukrainian). Kaunas, 23 pp.
- Sorokina L., 2003. Investigation of anthropogenic transformation connected with anthropogenic network creation (in Ukrainian). Geography Science and Education in Ukraine, Kyiv, p. 199–200.
- Shelyag-Sosonko Y., Zizin M., Zelensky M., 1981. Changes and perspectives of studying of vegetation recreation changes (in Ukrainian). Bot. J. Ukraine, 38, 5, 95–105.
- Tsaryk J., Gorban I., Holovachov O., Shydlovskyy I., Gorban L., Dyky I., Lesnik V., Matejchuk V., Pudlyk J., Senyk M., 2002. Ekological factors influencing biodiversity preservaion in tht Shatsk national natural park. Acta Agrophysica, 67, 275–285.

#### WPŁYW PRESJI REKREACYJNEJ NA STABILNOŚĆ I RÓŻNORODNOŚĆ BIOLOGICZNĄ EKOSYSTEMÓW LEŚNYCH: PRYPADEK SZACKIEGO PRZYRODNICZEGO PARKU NARODOWEGO

**Streszczenie.** Szacki Przyrodniczy Park Narodowy położony jest w zachodniej części Polesia, w dorzeczu Prypeci i Bugu, na terytorium Ukrainy, w pobliżu jej granic z Polską i Białorusią. Rekreatywnie wykorzystanie środowiska przyrodniczego na terenie Szackiego PPN skoncentrowane jest w pobliżu jezior Świtez i Piaseczno oraz otaczających je lasów. W ich otoczeniu powstały 4 strefy zagospodarowania rekreacyjnego. W toku badań ustalono, że największą odporność na obciążenia ruchem turystycznym mają siedliska suche. Z kolei najbardziej atrakcyjne dla wypoczywających są lasy mieszane na siedliskach suchych i świeżych (kategoria C1 i C2), o dużej różnorodności biologicznej. Granica odporności lasów na obciążenia rekreacyjne w warunkach Szackiego PPN została już osiągnięta na siedliskach wilgotnych i bagiennych. Rozwój powierzchni obszarów objętych czwartą fazą degradacji ekosystemów leśnych powoduje wypieranie z tych terenów gatunków dzikich zwierząt leśnych, a jednocześnie sprzyja wkraczaniu obcych dla tych biocenoz gatunków synantropijnych. Zjawiska te powinny być sygnałem do pilnego opracowania planu ochrony przyrody Szackiego PPN.

**Słowa kluczowe:** Szacki Przyrodniczy Park Narodowy, ekosystemy leśne, presja rekreacyjna, różnorodność biologiczna