

PRELIMINARY CONSIDERATIONS CONCERNING THE ROLE OF STÂNCA FOREST ECOSYSTEM IN THE CONSERVATION OF BIOLOGICAL DIVERSITY

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Abstract. The object of the researches serves the Stâncă forest ecosystem, located in the North of the Republic of Moldova, on the right coast of the Nistru river, at the border with the neighboring country, Ukraine. The study includes the appreciation of the general ecologic condition, determination of the sources and the level of pollution of the environmental components, the vegetation's description and registration of the flora and fauna species. Based on the estimation of the emissions from the local and transboundary sources, evaluation of the air quality, biota and soil it was established the fact that the studied object is characterized, in general, as having a satisfactory ecological condition. Based on the obtained results, there was observed that the forest ecosystem Stâncă contains a rich diversity of plants and animals species and serves as favorable habitat for 5 species that were not indicated before for this ecosystem. In order to create favorable living conditions for the rare plants and animals species, there is suggested that the forest ecosystem Stâncă should be taken under the state's protection and considered a connecting corridor to the National and International Ecological Network.

Keywords: forest ecosystem, conservation of biological diversity, rare species, ecological condition, heavy metals.

Rezumat. Considerații preliminare privind rolul ecosistemului forestier Stâncă în conservarea diversității biologice. Obiectul cercetărilor se referă la ecosistemul forestier Stâncă, amplasat în regiunea de nord a Republicii Moldova, pe malul drept al fluviului Nistru, la hotar cu țara vecină, Ucraina. Studiul a inclus aprecierea stării ecologice generale, stabilirea surselor și nivelului de poluare a componentelor de mediu, descrierea vegetației și înregistrarea speciilor de floră și faună cu evidențierea speciilor rare și protejate la nivel național și internațional. În baza estimării emisiilor de la sursele locale și transfrontaliere, evaluării calității aerului, biotei și a solului a fost constatat faptul că obiectul cercetat se caracterizează, în general, printr-o stare ecologică satisfăcătoare. În baza rezultatelor obținute a fost constatat că ecosistemul forestier Stâncă conține o diversitate bogată în specii de plante și animale și servește ca habitat favorabil pentru 5 specii anterior neindicate pentru acest ecosistem. Pentru crearea condițiilor favorabile de trai a speciilor rare de plante și animale este propus ca ecosistemul forestier Stâncă să fie luat sub protecția statului și considerat coridor de conexiune la Rețeaua Ecologică Națională și Europeană.

Cuvinte cheie: ecosistem forestier, conservarea diversității biologice, specii rare, starea ecologică, metale grele.

INTRODUCTION

The degression of the biological diversity is an indicator of the antropic impact, whose consequences are felt more frequently in the last period of time. This way, the legislations are welcomed, environmental conventions as well, that are ment to call for all the peoples in the world to preserve the biodiversity in various aspects.

One of the most valuable vegetal formation is the forest. In the Republic of Moldova, the surface of the lands covered with forests is 374.5 thousands ha or 11.4% from the country's land surface, which is under 15% and ensures the ecological balance. Approximately 20% from the surface of the forests are taken under the state's protection, with the purpose of biological biodiversity's conservation (GALUPA & TALMACI, 2011).

One of the essential measures taken for the conservation of plants and animals species, with the purpose of maintaining the natural ecological balance, is long-term protection and management of natural resources, rational conservation and use of habitats, restoration and expansion of their surface.

Ecological function of the representative forest ecosystems is essential by the fact that they serve as a base for the formation of the National and European Ecological Network, they are preferred habitats for a lot of plants and animals species and are excellent atmosphere purifiers.

The irregular location of the protected forest areas (condensed more in Central regions and less in the North and South of the country), as well as their spatial fragmentation, do not assure a full functionality of the connection corridors to the National and European Ecological Network. So, there appears the necessity to extend the fund of protected areas, based on new forestry sectors that will be able to assure favorable living conditions for the local valuable species and migratory ones.

MATERIAL AND METHODS

The researches were made during the year 2011. There were evaluated the actual ecologic condition of the ecosystem, the quality of the environmental components, registered flora and fauna species and established their protection status. The floristic-faunistic research was done seasonally, with the registration of plants and animal species and collection of the samples that were supposed to be determined further (IVAN & DONIȚĂ, 1975). The systemic belonging of the species was established using the specialised determination books (BEGU *et al.*, 2005; GHEIDEMAN, 1975; GROSSU, 1986; MUNTEANU & LOZAN, 2004; SIMONOV, 1978) and MBS-10 and Micmed-5 microscopes. The

Register concerning representative species of vegetation and animals, rare species, species protected at national and international level, was prepared taking into account the IUCN Red List, 2008, but the protection status at national, regional and international level – according to NEGRU *et al.*, 2002; OLTEAN *et al.*, 1994; Red Book of Moldova (RBM), Romania Red List (RRL), Red Book of Ukraine (RBU), European Red List (ERL), Washington Convention (C Wash.), Bern Convention (C Bern), Bonn Convention (C Bonn).

The heavy metals content (Pb, Cd, Cr, Ni, Zn, Cu) from soil and molluscs shells was determined using the roentgen fluorescence spectrometry method, according to *Metodica vipolnenia izmerenii massovoi doli metallov...*, 2002.

The characteristic of the local pollution sources of the atmospheric air was performed according to the information from the Statistics Department, the effects of the transboundary pollution, according to the European program EMEP (1998), but the air quality – according to the gradations of the air quality's evaluation (BEGU, 2011).

RESULTS AND DISCUSSIONS

Location and physical-geographical conditions. Stâncă forest has the surface of approximately 100 ha and is located in Ocnita district, in the North of the Republic of Moldova, in the geomorphologic district Platoul Moldovenesc, which is a little higher plain, sloping to the South. The altitude varies between 240 and 320 m (Fig. 1). The climatic conditions from the region are more favorable, comparing to the regions from the Centre and South of the country. The climate is temperate continental. Winters are mild, short, with little snow, summers – hot and long. The length of the sunny days during a year in the northern part varies, by average is 2 060 sunny hours, and the average annual air temperature is +8, +9°C. In the active vegetation period, the sum of the average daytime air temperatures are 2 750-2 800 °C, and the sum of precipitations is 330-350 mm (LASSE, 1978).

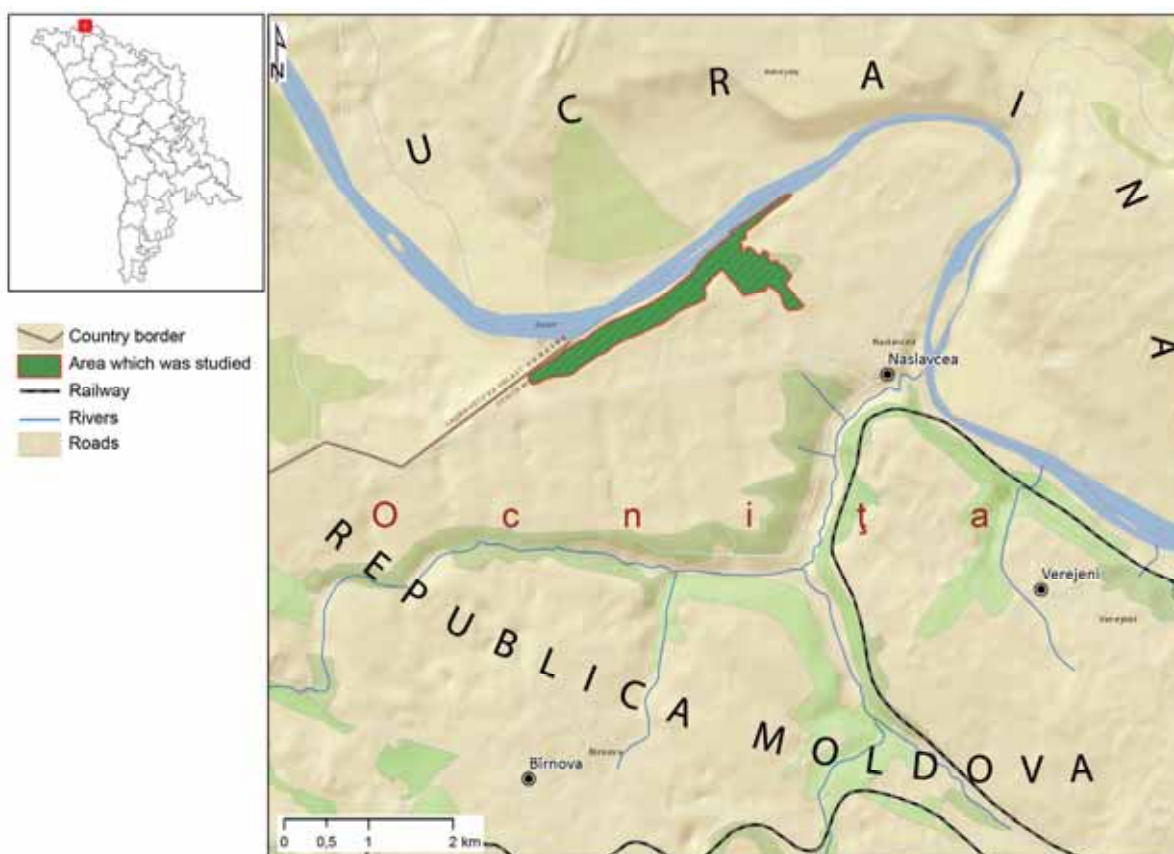


Figure 1. The scheme of the location of the forest ecosystem Stâncă.
 Figura 1. Schema amplasării ecosistemului forestier Stâncă (original).

In the North of the republic, where our object of study is located, the predominant types of soil are gray – light gray and dark gray (URSU, 2011), and the forest vegetation is dominated by *Quercus petraea* LIEBL. and *Cerasus avium* (L.) MOENCH (POSTOLACHE, 1995).

The local and transboundary impact. The analysis of the emissions from the pollution sources of the area where the studied object is located, shows a big decrease of the main emissions by the last 10 years, NO_x (NO₂, NO,..) and SO₂ can affect vulnerable flora and fauna. Therefore, the NO_x content is reduced by approx 100 times, and SO₂

content – by approximately 70 times (Table 1). This decrease is justified by the object's geographical location (Southern exposure and altitude within 240 and 320 m limits).

Comparing the level of these pollutants with the maximum admissible concentration, we find out that their concentration in the atmospheric air is lower than 0.1 MAC (maximum allowable concentration), that proves the absence of NO_x and SO₂ air pollution from this region.

Table 1. Emissions from the local pollution sources.

Tabel 1. Emisii de la sursele locale de poluare.

Emissions, t/year	1990 year	2010 year
NO _x	201	2.9
SO ₂	2043	31.5

According to EMEP, 1998, the annual quantity of wet and dry deposits in the perimeter of the quadrat 86 x 64 (50 km²), where is located the studied object, from local and transboundary sources is 4.5 kg N/ha and 6.7 kg S/ha (Table 2). This is within the limits for the Republic of Moldova (KIRILIU, 2006).

Table 2. Pollutants emissions and deposits.

Tabel 2. Emisii și depuneri de noxe.

Pollutants	Emissions	Atmospheric precipitations	Limits for the Republic of Moldova
Compounds N-NO ₃	↑ 2.9 t/an	↓ 4.5 kg/ha = 282 t/year/district	3.2 – 9.3 kg/ha
Compounds S-SO ₄	↑ 31.5 t/an	↓ 6.7 kg/ha = 442 t/year/district	5.8 – 8.9 kg/ha

The air's quality also indicates about a insignificant pollution, which was realized through lichenoindication, based on the specific diversity, abundance (% from the substrate surface) and lichens frequency in the studied object. In the forest ecosystem Stanca were registered species with a different degree of toxicotolerance. The species with 1st degree of toxicotolerance are: *Usnea hirta* and *Peltigera canina*, both having the abundance of 5%, species with 2nd degree – *Parmelia sulcata* – 15%, *Evernia prunastri* – 12%, *Graphys scripta* – 5% and *Cladonia pyxidata* – 3%; with 3rd degree – *Parmelia olivacea* – 5% and with 5th degree of toxicotolerance – *Xanthoria parietina* – 15%. Based on the gradations gradations of air quality evaluations (BEGU, 2011) there was established that SO₂ concentration in air fits the range of 0.1-0.2 mg/m³, which indicates a moderate air pollution in the ecosystem.

Along with other pollutants, the ecologic equilibrium could be disturbed by the heavy metals. They have cumulative properties in all the ecosystem's components and their effects are manifested in certain time periods. So, we have made researches concerning the heavy metals content (Pb, Cd, Cr, Ni, Zn, Cu) in soil and *Helix pomatia* molluscs shells from the forest ecosystem Stanca. The results of the heavy metals content in soil and the molluscs shells (Table 3) do not exceed the maximum allowable concentration (KIRILIU, 2006). Nevertheless, we can mention a trend of Pb and Cr cumulation in soil, what probably comes from transboundary sources, because upstream the object's location, on the Nistru river there functions the Novodnestrovsc hydropower station.

Table 3. The heavy metals content in soil and *Helix pomatia* shells.Tabel 3. Conținutul metalelor grele în sol și cochilile de *Helix pomatia*.

No.	Ecosystem components	Heavy metals, mg/kg				
		Pb	Cr	Ni	Zn	Cu
1	Soil (0-10cm)	20.4	74.3	8.2	56.5	10.8
	MAC	30.0	100.0	100.0	300.0	100.0
2	shells	0.25	0.17	0.27	0.32	1.52
	MAC	2.0	2.0	0.8	1.6	2.4

The comparative analysis of heavy metals content from these components proves the absence of heavy metals pollution of the forest ecosystem Stanca.

Flora and fauna. The forest vegetation is dominated by *Quercus petraea* LIEBL., subdominant are the *Acer campestre* L. and *Cerasus mahaleb* (L.) MILL., as well and on the edges, there appears *Pinus silvestris* L.

Among the shrubs and semi-shrubs, the most frequently met are the *Prunus spinosa* L. s. 1, *Rosa canina* L., *Cornus mas* L., *Ligustrum vulgare* L., *Crataegus curvisepala* LINDM., *Amygdalus nana* L. – R (rare species for the Republic of Moldova), *Rhamnus tinctoria* WALDST. et KIT. – R, RBM, RBU; *Cotinus coggygria* SCOP., *Genista depressa* BIEB., *Caragana mollis* (BIEB.) BESS., *Lonicera xylosteum* L., *Thymus moldavicus* KLOK. et SCHOST.

The herbs layer is well developed and is formed from common species, including a significant number of rare species, with different status of protection (Fig. 2).

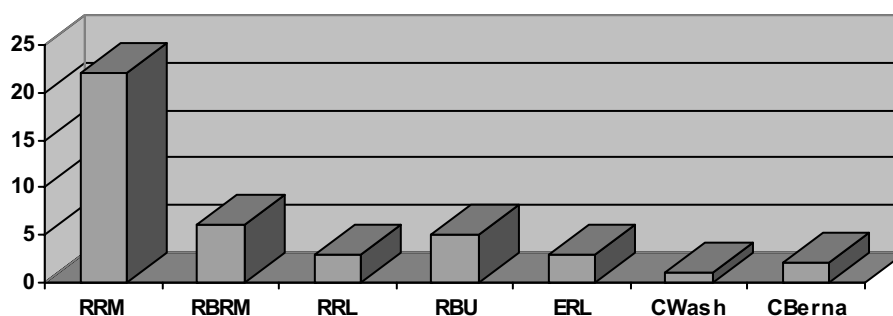


Figure 2. The number of rare species from the forest ecosystem Stâncea.

Figura 2. Efectivul speciilor rare din ecosistemul forestier Stâncea.

In open spaces, large glades and edges, in the springs, there were registered a lot of ephemeroïd species – *Primula veris* L. – R; *Pulsatilla grandis* WEND. – RBM, RRL, RBU; *Adonis vernalis* L. – R, RBU, CWash; *Anemone nemorosa* L. – R and under the trees canopy – *Ranunculus casubicus* L., *Hepatica nobilis* MILL. – R, RBM; *Lilium martagon* L. – R, RBU, ERL. Among the herbicid layer's edificators, from the forests with oak and cherry there were emphasized: *Polygonatum latifolium* (JACQ.) DESF., *Polygonatum odoratum* (MILL) DRUCE, *Thalictrum minus* L., *Asparagus tenuifolius* LAM. – R; *Melica uniflora* RETZ. The sectors with rocks and calcareous bedrock are populated by petrofit and calcifil species: *Sedum acre* L., *Sedum maximum* (L.) HOFFM., *Asplenium trichomanes* L. – R; *Asplenium ruta muraria* L. – R; *Athyrium filix-femina* (L.) ROTH - R, RBM; *Vinca minor* L. – R.

Common are the species: *Campanula persicifolia* L., *Hypericum perforatum* L., *Chelidonium majus* L., *Astragalus glycyphyllos* L., *Hieracium pilosella* L., *Veronica prostrata* L., *Silene nemoralis* WALDST. ET KIT, *Medicago minima* (L.) BARTALINI, *Melandrium album* (MILL) GARCKE, *Pyrethrum corymbosum* (L.) SCHRANK, *Lotus corniculatus* L., *Coronilla varia* L., *Filipendula vulgaris* MOENCH, *Leucanthemum vulgare* LAM.

Moss: *Polytrichum formosum* HEDW.

Lichens: *Cladonia pyxidata* (L.) HOFFM. – R; *Evernia prunastri* (L.) ACH., *Parmelia sulcata* TAYL., *Peltigera canina* (L.) WILLD. – R, RBM; *Usnea hirta* (L.) WIGG.– R, RBM; *Graphys scripta* (L.) ACH.– R; *Parmelia olivacea* (L.) ACH. EMEND. NYL. – R; *Xanthoria parietina* (L.) BELT.

Fauna: *Sus scrofa* LINNAEUS 1758, *Capreolus capreolus* LINNAEUS 1758 – RRL, ERL, *Helix pomatia* LINNAEUS 1758 – R, C Berna, *Cepaea vindobonensis* FÉRUSAC 1821, *Amata phegea* LINNAEUS 1758.

Among the listed species there were registered 22 rare species, with national, regional and international level of protection (included in RBM, RRL, RBU, ERL and environmental Conventions). Five species of rare plants were registered for the first time in Stanca ecosystem (Fig. 3).

We have ascertained that some rare species, that were registered in Stâncea ecosystem, are indicated, as well, in the ecosystems from the Nistru river meadow, on the left shore, in Ukraine. They are: *Rhamnus tinctoria* and *Pulsatilla grandis* – included in RBM and *Lilium martagon* and *Adonis vernalis* – R. If for the last 2 species there is indicated a big number of habitats in RBU, then for the *Pulsatilla grandis* species, the area of exposure is smaller, prevailing are the habitats from the North-West of Ukraine. In RBU for *Rhamnus tinctoria* are indicated just a few habitats, 2 of them - vis-à-vis of the studied ecosystem.

The mentioned before are in support of protection of forest ecosystem Stâncea, which will serve as ecological corridor linking the objects from National Forest Network and the Regional one.

CONCLUSIONS

Forest ecosystem Stâncea assures optimal conditions for 22 flora and fauna rare species, and for 5 of them (*Pulsatilla grandis*, *Hepatica nobilis*, *Rhamnus tinctoria*, *Peltigera canina*, *Usnea hirta*) is a new habitat, not mentioned before in normative documents.

Rare species presence in this ecosystem is an indicator of a favorable ecologic condition. Heavy metals content from the ecosystem's components do not exceed MAC ranges and shows the absence of heavy metals pollution of the ecosystem. The SO₂ content in the air, which is within the limits of 0.1-0.2 mg/m³, signifies a **moderate pollution**.

In order to assure the conservation of plants and animals rare species, there is suggested that forest ecosystem Stanca to be taken under the state's protection and to have assigned the category of Landscape Reservation.

Forest ecosystem Stanca ca serve as connecting corridor to the National and European Ecological Network, because here were registered rare species for the North-East region of the Republic of Moldova and for the Western sectors of Ukraine.

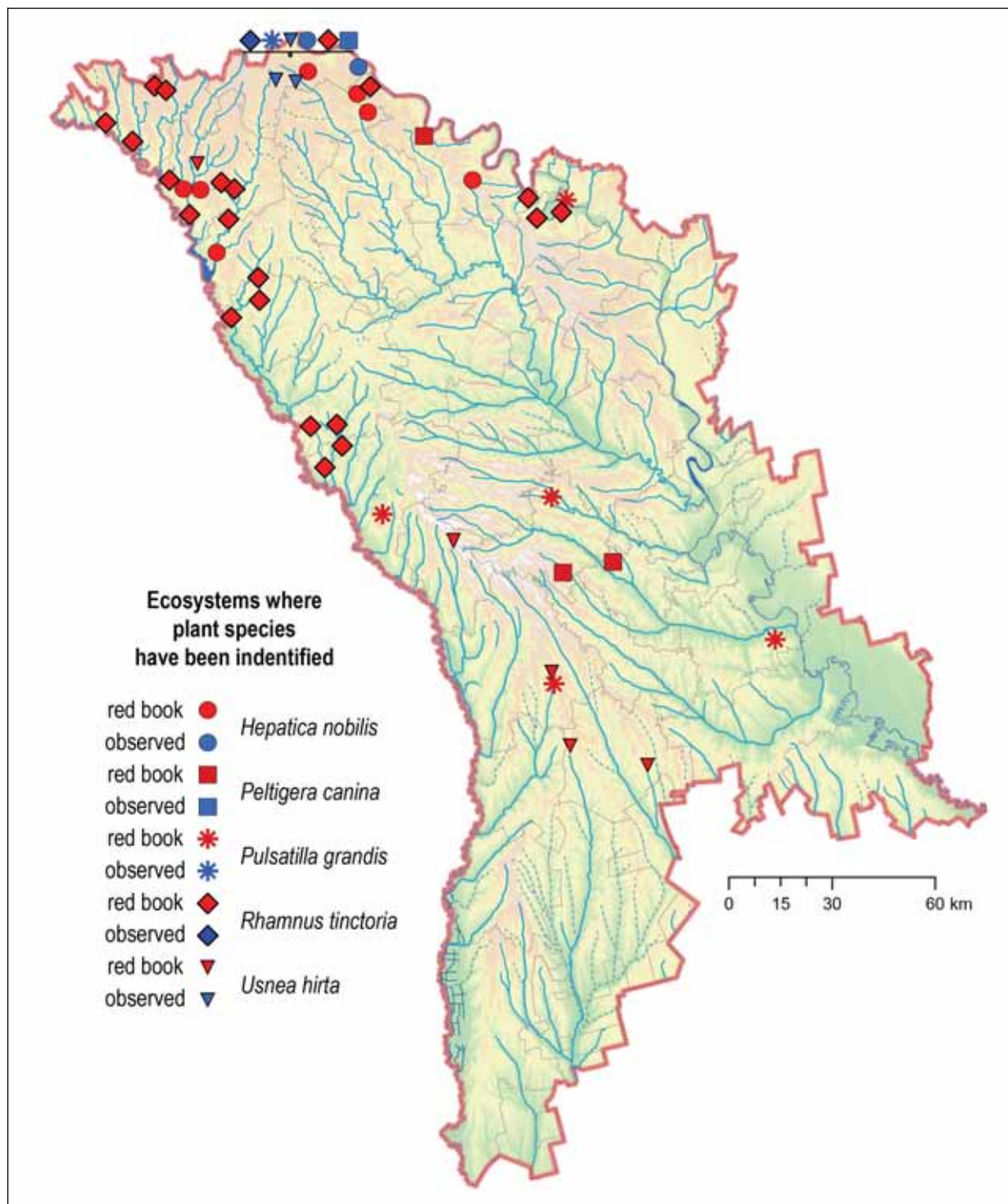


Figure 3. Rare species that were not indicated before in forest ecosystem Stâncă.
 Figura 3. Specii rare neindicate anterior pentru ecosistemul forestier Stâncă.

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