Peculiarities of the floristic composition and phytocenotic spectra of the prospective conservation area "Siverga" (Tyumen Oblast, Russia)

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Abstract. The coastal zone of the Lake Siverga (Tyumen Oblast, Russia) is characterized by a high level of floristic and phytocenotic diversity, which significantly increases the conservation status of the prospective protected area "Siverga", limited by the coastline of the lake. Twelve vascular plants species included into the Red List of the Tyumen Oblast have been found on the surveyed territory. The plant communities, which are extremely rare in the region, have been observed on the coastal salt marshes; these communities have been previously noted only in the southern areas of the European part of Russia. Taking into account these results, we argue for expanding the boundaries of the protected natural area, which must include the floodplain areas and slopes of the floodplain terrace adjacent to the lake water area.

1. Introduction

"Siverga" is a site reserved for a specially protected natural area of regional significance, including the Lake Siverga [1]. This protected area aims to preserve unique natural hydrological complexes, as well as to provide recreational and medicinal resources. The area of the protected territory is 5360 ha. The border of the territory has a length of 53 km and runs along the edge of the Lake Siverga [1].

The Lake Siverga is a bitter-salty shallow-water suffusion lake [2]. It is located in the Kazansky and Berdyuzhsky districts of the Tyumen Oblast (Russia) and in the Kyzylzhar District of Kazakhstan (Figure). The territory belongs to the middle forest-steppe subzone, the forest-steppe natural zone, the Berdyuzhsky sub-province, the Ishim province, the forest-steppe plain zone of the West Siberian ecoregion [3]. In the vicinity of the Lake Siverga, flat clay plains with depressions and wormwood-fescue and saltwort-sagebrush groups located on salt marshes are widespread; the soils are meadow and meadow-chernozem, varying degrees of saline (solonchak), in combination with reed beds on meadow-boggy soils are present [4]. The lake is surrounded by agricultural lands, which alternate with birch and aspen forests and sites of pristine meadow steppes. Salt marshes and salt meadows with a complex of halophilic vegetation are widespread along the lake coast; the plantations of Pinus sylvestris locate on the valley walls in some areas. The combination of sites with different complexes and types of vegetation (saltwater, salt marsh, salt-meadow, freshwater, steppe, small-leaved forest,
light-conifer forest) makes this territory a unique natural object for the Tyumen Oblast. The communities that make up the vegetation cover of the water area and the coastal zone of the lake attract much attention in regard to their floristic and phytocenotic diversity. They have not yet been discussed in the scientific literature. The coastal zone is of great environment-forming importance. The study aims (1) to describe the peculiarities of original floristic composition and phytocenotic spectra of the water area of the Lake Siverga and the adjacent coastal zone and (2) to establish the conservation value of this territory.

Figure. Location of the Lake Siverga in the Tyumen Oblast. Red line in the inset indicates the boundaries of the Tyumen Oblast, white rectangle, the enlarged area of the map.

2. Materials and Methods
A botanical survey of the water area of Lake Siverga and the adjacent territory within the Kazansky and Berdyuzhsky districts of the Tyumen Oblast was performed in 2018–2020. The studied area is limited by the edge of the lake floodplain terrace and includes a number of small artificial freshwater reservoirs, as well as salt lakes, several fresh and salt water streams, forest sites, salt marshes, steppe and saline meadows. The surveyed area was about 45 km². The floristic composition of vascular plants was studied by the route census, all ecotopes were analyzed. Complex geobotanical descriptions were carried out at some sites. In aquatic habitats, the water temperature and the amount of salts dissolved in the water (water salinity) were measured using a portable ST 20S salt meter. The geographical coordinates of the growing sites of protected species of vascular plants were obtained by Garmin GPSMAP 64st handheld navigation unit.

The aquatic habitats are characterized by the degree of water salinity, in accordance to the scale suggested by O.A. Alekin [5]. The nomenclature of vascular plant species is given in accordance with the "Synopsis of the Flora of the Asian Part of Russia" [6]. The nomenclature of taxa at the family level and higher levels and their locations are given in accordance with the APG-IV system [7].
Geobotanical relevés were made for the 4-m² sites using standard techniques [8]. The descriptions were then introduced into a database developed on the basis of the TURBOVEG program [9] and processed using the JUICE program [10]. The total grass projective cover was estimated as a percentage (%). The abundance scale by J. Braun-Blanquet was applied to assess the abundance of plant species on the survey sites [11]. Syntaxonomic analysis was performed using the approach suggested by J. Braun-Blanquet [12]. The names of syntaxa are given according to the "International Code of Phytosociological Nomenclature" [13]. The system of higher syntaxa is given in accordance with "Vegetation of Europe..." [14].

The collected herbarium materials are stored in the herbarium of the Tobolsk Complex Scientific Station of the Ural Branch of the Russian Academy of Sciences (Tobolsk, Russia).

3. Results and Discussion
Analysis of the botanical materials makes it possible to identify eight types of ecotopes, differing in the composition of plant groups, within the study area:

1. Shallow waters of the Lake Siverga, where the water temperature and salinity are the main environmental factors affecting plants.
2. The flooded shores of the Lake Siverga and channels between salt lakes; water salinity and water level are the most important factors here.
3. Freshwater habitats, represented by anthropogenic water bodies, i.e. ponds and flooded pits.
4. Coastal hydromorphic salt marshes.
5. Coastal saline meadows.
6. Xeromorphic habitats of the slopes of the terrace above the floodplain of the Lake Siverga.
7. Forested sites of the floodplain and slopes of the terrace above the floodplain of the Lake Siverga.
8. Ruderal habitats (dams, soil roads, idle lands).

The floristic composition of pine plantations was not taken into account, since these communities were located in non-floodplain habitats.

These types of ecotopes differ both in their landscape location and in the composition of plant communities.

There were 216 vascular plant species found for the study area within the performed surveys. About a half of them were found in xeromorphic habitats, including four species of vascular plants included into a regional Red List [15]: Helictotrichon schellianum (Hack.) Kitag., Peucedanum morisonii Bess. ex Spreng., Salvia stepposa Shost., and Stipa pennata L. Six endangered species were found on saline meadows of the lake's floodplain, including Fritillaria meleagroides, Ranunculus silvestraceus, and Rhaponticum serratuloides. F. meleagroides was found only in the Berdyuzhsky and Kazansky districts [16], mainly in the coastal meadows of the lakes Siverga and Akush. Earlier, it has been reported on a single locality of R. silvestraceus in the region, namely, the Uporovsky District [16]. Our finding of R. silvestraceus in the Kazansky District on the coastal saline meadow of the Lake Siverga is the second locality of this rare species in Tyumen Oblast, which significantly increases the conservation status of the considered area. R. serratuloides is also known from the Armizonsky District, in addition to the Berdyuzhsky and Kazansky districts, but it is also considered as a rare species for the region. This species has been found in several sites within our study area, where it grows in large aggregations (over 50 specimens).

In the ecotopes nos. 1, 2, 4, and 7, there was only one endangered species per ecotope found. The ecotope no. 1 is actually represented by the shallow water of the Lake Siverga, where the salinity of the water reaches 37.7‰. Here, only one vascular plant species has been registered, Ruppia maritima. This is the only one known location of this species in the Tyumen Oblast. Scorzonera parviflora, growing in the phytocenoses of the ecotopes no. 2, is known from a number of southern areas of the region [16]. In the surveyed area, it is quite common in the wet sites of saline meadows and watered shores of the Lake Siverga and other salt water bodies. Limonium capsum is a very rare Black Sea-Kazakhstan-Central Asian species, known in the region only from the shores of the Lake Siverga,
where it prefers to grow in weakly turfed areas of wet saline meadows (ecotope no. 4). This species is a part of the communities of herbaceous and semi-shrub halophytes, primarily in the *Halimione verrucifera* community; the last is also known only from the saline coasts of the lakes Siverga, Gor'koe, and Kolovo in the region [17]. *Cerasus fruticosa* is one of the most widespread threatened species in the study area, which is a part of the undergrowth of birch and aspen forests. Endangered/threatened plant species have not been found only for communities of the ecotopes nos. 3 and 8, which are of anthropogenic origin. However, there were some rare species found in these ecotopes, namely, *Typha angustifolia* L. [18], *T. laxmannii* Lepech., *Ceratophyllum submersum* L., and *Echium vulgare* L. [16].

In general, twelve species of vascular plants considered threatened/endangered in the Tyumen Oblast have been registered for the studied area. They belong to the steppe, halophilic and saltwater vegetation complexes and have a rarity status of 1—3. The state of the studied populations of these vulnerable species may be assessed as satisfactory. There are some concerns about the populations of *Ranunculus silvisteppaceus*, *Helicotrichon schellianum*, and *Peucedanum morisonii* due to the small area occupied by these species in the studied territory. The site of the saline meadow with the population of *R. silvisteppaceus* is currently not used for the economical purposes. The chances for preserving the population of this species will increase many times if a conservation regime will be established for this area. *H. schellianum* and *P. morisonii* grow together on a small site of the xerothermal carbonate slope of the terrace above the floodplain of the Lake Siverga, adjacent to the agricultural field. Any increase of the anthropogenic impact on this site will lead to the extinction of these species.

It should be noted that the communities, where *Halimione verrucifera* dominates and *Limonium caspium* is present, are very rare and are known in the region only for the coastal salt marshes of the Lake Siverga. These communities are found nearly in each part of the coastal zone, i.e. in the eastern, northern, and western parts of the lake. These communities belong to association *Limonio caspic-Halimionetum verruciferae* Lysenko 2011, alliance *Artemisio santonicae-Puccinellion fomini* Shelyag-Sosonko et al. 1989, order *Halimionetalia verruciferae* Golub et al. 2001, class *Kalidietea foliati* Mirkin et al. ex. Rukhlenko 2012. The communities of this association are typical for the steppe zone of the European part of Russia, but they are found rarely. Previously, they were described for the small shallow depressions on the terraces of the Kochevnaya and Gusikha rivers, on the meadow-chernozem solonchak soil (Bol'shechernigovsky District, Samara Oblast), and on the low terrace of the Lake El'ton, on the light-maroon solonchak soil (Pallasovsky District, Volgograd Oblast) [19].

Therefore, the surveyed area is characterized by a high plant diversity. This should be taken into account when establishing a protection regime for the water area of the Lake Siverga and the adjacent coastal zone. The proposed boundary of the protected area runs approximately along the edge of the terrace above the floodplain of the lake and includes the reported populations of vascular plants species protected in the Tyumen Oblast.

**4. Conclusion**

The studied coastal zone adjacent to the water area of the Lake Siverga is characterized by a high diversity of the vascular plant species and by a number of species included in the regional Red List. This significantly increases the conservation status of the coastal zone of the lake. Twelve endangered/threatened plant species belonging to the steppe, halophilic and saltwater complexes have been registered within the surveyed area. In addition, there are rare plant communities that are not observed anywhere else in the region, which include plant species that are found rarely within the Tyumen Oblast. Our results evidence on the high conservation value of the considered area. Therefore, we recommend to include the lake coast into the boundaries of a specially protected natural area of regional significance "Siverga", which will significantly increase its status of a conservation area.

**References**
[1] On measures to determine and reserve lands of specially protected natural regional values (as amended on February 21, 2018): Decree of the Government of the Tyumen Oblast dated December 30, 2014 No. 735-p Codex Consortium: Electronic Fund of Legal and Regulatory and Technical Information URL: http://docs.cntd.ru/document/423908068

[2] Pereladova L V 2017. The influence of genesis on the morphology and morphometry of lakes in the forest-steppe zone of the Tyumen Oblast Results and prospects of scientific research 4 (Krasnodar: Publishing house: Individual entrepreneur Akelian Narine Samadovna) pp 92–103

[3] Gvozdetsky N A, Krivolutsky A E and Makunina A A 1971 Physical and geographical zoning Atlas of the Tyumen Oblast. Is. 1 (Moscow–Tyumen: Main Directorate of Geodesy and Cartography under the Council of Ministers of the USSR) sheet 27 pp 3–6

[4] Isachenko A G, Makunina A A, Maslennikova V V, Melnikov E S, Selezeva N S and Tagunova L N 1971 Landscapes Atlas of the Tyumen Oblast. Is. 1 (Moscow–Tyumen: Main Directorate of Geodesy and Cartography under the Council of Ministers of the USSR) sheet 26

[5] Nikanorov A M 2001 Hydrochemistry: Textbook (St.-Petersburg: Hydrometeoizdat)

[6] Baikov K S (ed.) 2012 Synopsis of the flora of the Asian part of Russia: Vascular plants (Novosibirsk: Publishing house SB RAS)

[7] The Angiosperm Phylogeny Group IV. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV 2016 Bot. J. of the Linnean Society 181 (1) 1–20 DOI:10.1111/bot.12385

[8] Yaroshenko P D 1969 Geobotany: a guide for students of pedagogical universities (Moscow: Education)

[9] Hennekens S M 1996 TURBO(VEG). Software package for input, processing, and presentation of phytosociological data. Users guide. Version July 1996 (Lancaster: IBN-DLO)

[10] Tichý L 2002 JUCIE, software for vegetation classification J. Veg. Sci. 13 pp 451–3

[11] Alexandrova V D 1969 Vegetation classification. Review of classification principles and classification systems in different geobotanical schools (Leningrad: Science. Leningrad department)

[12] Braun-Blanquet J 1964 Pflanzensoziologie. Grundzüge der Vegetationskunde 3 Aufl. (Wien–New York)

[13] Weber H E, Moravec J, Theurillat J-P 2000 International Code of Phytosociological Nomenclature. 3rd edition J. Veg. Sci. 11 739–68

[14] Mucina L et al. 2016 Vegetation of Europe: Hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities Applied Veg. Sci. 19 (1) 3–264

[15] The list of species of animals, plants and fungi that call to be entered in the Red Book of the Tyumen Oblast: Appendix to the Decree of the Government of the Tyumen Oblast of November 29, 2017 No. 590-p Official Internet portal of legal information URL: http://publication.pravo.gov.ru/Document/View/7200201712010002?index=5&rangeSize=1.

[16] Glazunov V A, Naumenko N I and khozyainova N V 2017 Determinant of vascular plants of the Tyumen Oblast (Tyumen: OOO RG Prospect)

[17] Kapitonova O A 2019 Additions to the flora of the Tyumen region Bulletin MOIP. Dept. Biol. 124 (3) 71–2

[18] Kapitonova O A, Zarubina E Yu and Kharitontsev B S 2020 Typha angustifolia (Typhaceae) in Western Siberia Bot. J. 105 (8) 770–8 DOI: 10.31857/5S0006813620080086

[19] Lysenko T M 2016 Vegetation of saline soils within the forest-steppe and steppe zones (Moscow: Association of scientific publications KMK)