Rare and in need of further preservation plants of Krasnoyarsk flora

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Abstract. The consequences of increasing urbanization in the modern world are in the field of knowledge of a wide variety of sciences, while one of the most important aspects of this problem is monitoring the biological diversity of urban areas, as the main condition for their sustainable ecological development. The study of urban flora is one of the priority areas of modern floristry and phytogeography, the scientific value of which is steadily increasing due to the strengthening, both in time and in space, of anthropogenic pressure. The purpose of the article is to identify plant species for the Red List of Threatened Animals and Plants of the Krasnoyarsk Territory in the urbanized landscape of the city of Krasnoyarsk and to determine their status. As a result of the study, 56 species of protected plants in Krasnoyarsk were identified, proposed for protection in the new edition of the regional Red List of Threatened Animals and Plants of 2022. A list of Red List of Threatened Animals and Plants species was compiled indicating the main habitats and distribution in 26 established and studied model sites within the city. For each species, Latin and Russian names, main habitats, frequency of occurrence and abundance are given, in the case of authors’ own collections. The statuses of rare species of Krasnoyarsk have been determined: 1 species has an indefinite status - 4 (I); 28 species have the status 3 (R) - rare species; 25 species have status 2 (V) - vulnerable species, 2 species with status 1 (E) - endangered species.

1. Introduction
The city of Krasnoyarsk is an amazing territory, which is famous not only for its history and monuments of different eras, but also for its extraordinary natural wealth. In today’s conditions of the accelerating pace of technological progress and spatial development of cities, a common task for all comes to the fore: to preserve the unique resources of flora and fauna. To do this, it is necessary to create Red List of Threatened Animals and Plants of various levels, in particular, of urban areas.

Due to the fact that the flora of the city is subject to strong anthropogenic pressure associated with man-made loads and recreation, studies of the sections of the zonal vegetation cover. They are not only habitats for rare and endangered species and serve as a natural obstacle to the spread of adventive plant species, but also easily vulnerable. So, for example, in the spring, cases of fires of dry grass, large-scale deforestation, etc. are very often recorded.

The purpose of this article is to identify plant species for the Red List of Threatened Animals and Plants of the Krasnoyarsk Territory (2022) in the urbanized landscape of the city of Krasnoyarsk and to determine their status.
2. Materials and methods
Identification of the flora of Krasnoyarsk was carried out using the method of model divisions of an urbanized landscape [1] in addition to route surveys. As a result, relatively equal, typical economic and geographical zones with pronounced ecological and visual isolation were identified on the territory of the city. Within the administrative boundaries of the city of Krasnoyarsk, 26 model plots of 250x250 m were laid. The trial plots were allocated in accordance with the phytocenotic diversity of the urban landscape and the characteristics of anthropogenic load.

3. Result and discussion
In order to assess the current state of rare and endangered plant species in the flora of Krasnoyarsk, we identified the growth of 56 species of vascular plants, which, according to the distribution and state of populations, have already been included in the Red List of Threatened Animals and Plants of the Krasnoyarsk Territory [2] and have now been proposed for protection in a new edition The Red Book of 2022, and also app

Below is a list of the city's plants in the Red List of Threatened Animals and Plants, indicating the main habitats and distribution over 26 established and studied model blocks within the city, indicated in the text by abbreviated transcription:

Vb - Verkhnyaya Bazaikha; Kk – Kamenny Kvartal; TC – Torgovy Tsentr; Vc - Verhnie Cheryomushki; Ud - p. Udachny; Kn - Ulitsa Kalinina; Pk - Pokrovka; PG - Gorky Park; Ot – Ostrov Tatysev; Bkh - Bazaikha; Se – Stantsiya Yeniisei; Psh - md. Pashenny; Pl – Plodovo-yagodnaya Stantsiya; Vzh - md. Veltuzhanka; BTs – Bolnitsa skoroi meditsinskoi pomoshchi; Peh - village Peschanka; Zd - Krasnoyarskiy Metallurgicheskiy zavod; Sch - md. Solnechnyi; MK - Myasokombinat; Bg - Bugach; Tm - the village of Tamyr; Gu - Krasnoyarsk State University (now SSU); NS - Nikolaevskaya Sopka; Ag - Akademgorodok; Oz – Ostrov Otydaya; Kch - r. Kacha.

For each species, Latin and Russian names, main habitats, frequency of occurrence and abundance are given, in the case of authors' own collections. The collections of the authors are cited without the indication of the surname [11].

3.1. List of protected plants in Krasnoyarsk
Nuphar pumila (Timm) DC. – Kubysheka malaya.
In shallow rivers with a quiet current, oxbows, on pebbles. It is very rare: Kk (Ladeiskie Ozera, 1928, Miklashevskaya, KKM) [12].

**Nymphaea tetragona** Georgi – *Kuvshinka chetyrekhugolnaya*.

Along lakes, slowly flowing rivers, oxbows. Very rare: Kk (Ladeiskie Ozera, 1940, Cherepnin, KRAS) [13, 14].

**Menispermum dauricum** DC. – *Lunosemmyannik daurskiy*.

On steeply steep banks, stony and lime placers, loose clay slopes, in thickets of bushes. Very rare. Collected once on the left bank of the river. Enisey: Ag (1954, Beglyanova, KRAS) [13, 14].

**Anemone caerulea** DC. – *Vetrenitsa golubaya*.

In sparse birch and mixed forests, bush thickets. It is very rare: Ud (Sobakina rechka, 1928, Vishniovskaya, TK) [12].

**Papaver chakassicum** Peschkova – *Mak khakasskiy*.

On stony steppe coastal slopes, rubble talus. Very rare. Collected once: Bkh (1969, Smirnova, TK) [13, 14].

**Corydalis subjenisseensis** E.M. Antipova – *Kholiatka priyeniseyskaya*.

In shrub thickets along river banks, on forest edges and tame lawns. It is very rare: Bg, Ns (1954, Cherepnin, KRAS), Oo (Stepanov, KRSU) [13, 14], Pl (2006, KRAS). Low abundance.

**Krascheninnikovia ceratoides** (L.) Gueldensst. – *Krasheninnikoviya tereskenovaya*.

On steep rocky slopes and talus, in the steppes. It occurs quite often: Ud (1949, Cherepnin, TK) [13, 14], Kk, Vch, Bkh, Psh, Vzh, Zd, Sch, Ns, Ag (2005, KRAS). Abundant in places.

**Phlox sibirica** L. – *Phlox sibirskiy*.

On rocky outcrops, gravelly slopes, coastal rocks, in the steppes. Very rare. Collected once: Ag (1996, Khilimanyuk, KRAS).

**Primula cortusoides** L. – *Pervotsvet kortuzovidny*.

n sparse birch forests, on forest edges, forest and steppe meadows. It occurs quite often: Ot, Pl, Vzh, Bts, Sch, Ag (2005, KRAS), Vb (2006, KRAS), Gu (2016, KRAS), Ns (2016, Antipova, KRAS). Low mobility.

**Primula serrata** Georgi – *P. pil’chaty*.

On wet and saline-marshy meadows. It is very rare: Bg (r. Bugach, 1986, Gladysheva, KRAS), Ud (Sobakina rechka, 1987, Menshakova, Korkina, KRAS).

**Viola dactyloides** Schult. – *Fialka pal’chataya*.

In pine forests, sparse birch forests. It is very rare: Ns (1956, Cherepnin, KRAS) [12, 15]. This locality is the westernmost for the species [13, 14].

**Viola dissecta** Ledeb. – *F. rassecnenaya*.

On steppe meadows, on southern gravelly slopes, young fallow lands. It is rare: Pk (Chasovennaya Gora, 1939, Cherepnin, KRAS), Ns (1958, Cherepnin, KRAS) [13, 14], Ot (1992, Goncharova, KRAS), Oo (Stepanov, KRSU) [16], Vch, Ot (2005, KRAS). Low mobility.

**Viola milanae** Vl. – *Phlox sibirskiy*.

Along the steep steppe and meadow slopes of the southern, southwestern and northern exposures. It is rare: Ud (Sobakina Rechka Valley, 1954, Cherepnin, KRAS), Bkh (1958, Cherepnin, KRAS), Ag (1954, Cherepnin, KRAS).

**Viola patrinii** Ging. – *F. Patrena*.

In meadows along river floodplains, islands. It is very rare: Oo (Telyachiy Island, 1906, Tugarinov; 1910, Ermolaev, KKM; Konny Island, 1912, Kuznetsov; Telyachiy Island, 1918, Konovalova, TK; 1939, Cherepnin, KRAS) [12].

**Cardamine impatiens** L. – *Serdechnik nedotroga*.

In the shade of bushes along the river banks. Very rare: Oo (1993, Stepanov, KRAS) [13, 14].

**Erysimum altaicum** C. A. Mey. – *Zheltushnik altaiskiy*.

In the stony steppes, along the southern rubble slopes. Very rare: Ag (2005, KRAS). Low mobility. The species is located on the northern border of the range.

**Astragalus palibinii** Polozhij – *Astragal Palibina*. 
On open stony and gravelly slopes, in shallow sod and meadow steppes. Very rare: Pk (Karaulnaya Gora), Zd (2005, KRAS). Abundant in places.

*Astragalus propinquus* Schischk. – *A. skhodny*.

On forest and steppe meadows, in forests, along their edges. It is very rare: Bkh (r. Bazaikha, 1941, Cherepnin, KRAS) [13, 14], Oo (Stepanov, KRSU) [16].

*Astragalus vaginatus* Pall. – *A. vlagalishchny*.

On forest and steppe meadows, in forests, along their edges. It is very rare: Bkh (r. Bazaikha, 1941, Cherepnin, KRAS) [13, 14], Oo (Stepanov, KRSU) [16].

*Astragalus versicolor* Pall. – *A. razno tsvetny*.

On open rocky and gravelly slopes, dry hills. Very rare: Bkh (Krasny greben’, 1927, Miklashevskaya, KKM) [12]. The species is located on the northeastern border of the range [14].

*Astragalus ammophilla* Turcz. – *Ostrolochoknik peskolyubivy*.

Along the steppe slopes. Collected once by V. Reverdatto: Bkh (1926, TC) [12, 17].

*Astragalus nuda* Basil. – *O. nagoy*.

On the rocky southern slopes. Very rare: Bkh (1910, Titov, KKM) [12, 17].

*Scrophularia multicaulis* Turcz. – *Norichnik mnogostebel’ny*.

In meadow steppes, meadow glades. It is very rare: Ns (1962, Kashina, KRAS) [13, 14].

*Veronica reverdattoi* Krasnob. – *Veronika Reverdatto*.

Along the steep rocky slopes. Very rare. The only location is noted on the 7th terrace of the river Yenisei, composed of Precambrian limestones, along the tops of the southern slopes in a real rocky steppe: Ud (House of rest, 1973, Smirnova, Beglyanova, Kashina, KRAS) [13, 14]. This locality is the extreme northeastern point for the species [20].

*Panzerina argyracea* (Kuprian.) V. Doronkin – *Pantserina serebristaya*.

In the forests and bushes in the floodplains of rivers, in meadows. It is very rare: Bg (1960, Cherepnin, KRAS) [13, 14].

*Gagea altaica* Schischk. et Sumnev. – *Gusinoluk altaisky*.

In meadow steppes, meadow glades. It is very rare: Ns (1962, Kashina, KRAS) [13, 14].

*Gagea fedtschenkoana* Pasch. – *G. Fedchenko*.

On rocky slopes, steppes and meadows, on steep coastal cliffs and ravines. Recorded repeatedly in
the 1940s and 1950s: Bg (1940, Cherepnin, KRAS), Ns (1946, Nekoshnova, KRAS), Bkh (1936, 1938, Vereshchagin, TK; 1957, Cherepnin, KRAS), Kch (1927, Kuntsevich; 1939, 1940, 1950, 1951, Cherepnin, KRAS, TK). The identified localities are located on the eastern border of the species range.

**Gagea longiscapa** Grossh. – *G. dlinnostrelkovy.*

Along steppe meadows, rocky slopes and cliffs. It is very rare: Bg (1940, Cherepnin, KRAS) [13, 14], Bkh (1958, Bazhenova, KRAS) [13, 14]. These localities are located on the northern border of the species range.

**Lilium pumilum** Delile – *Liliya karlikovaya.*

In meadow steppes, on open rocky slopes, steppe meadows. Very rare: Vch, Ud, Ag (2005, KRAS). Low mobility.

**Cypripedium calceolus** L. – *Bashmachok nastoyashchyy.*

In birch, pine and coniferous-deciduous forests. Very rare: Ag (2006, KRAS). Low mobility.

**Cypripedium guttatum** Sw. – *B. pyatnisty.*

In light birch and mixed forests, pine forests. It is very rare: Pl, Vzh, Bts, Ag (2005, KRAS), Gu (2016, KRAS). Low mobility.

**Cypripedium macranthon** Sw. – *B. kruptnotsvetkovy.*

In deciduous and coniferous-deciduous forests, pine forests. Very rare: Ag (2006, KRAS). Low mobility.

**Cypripedium ventricosus** Sw. – *B. vzduty.*

Mixed forb forests. Cited according to the data of L. V. Averyanov for the Krasnoyarsk forest-steppe [21].

**Epipactis helleborine** (L.) Crantz – *Dremlik zimovnilovy.*

In birch, mixed forests, forest glades. It is very rare: Ns (2005, KRAS), Pl (2006, KRAS). Low mobility.

**Neottia krasnojarica** Antipova – *Gnezdovka krasnoyarskaya.*

In deciduous forests, on the edges. It is rare. Collected in Bkh (1941, Cherepnin, KRAS), Ag (1986, E. Antipova, KRAS).

**Neottiana cucullata** (L.) Schltr. – *Gnezdotsvetka klobuchkovaya.*

In damp birch forests, pine forests, on forest edges. It is very rare: Vzh, Pl, Bts, Ag (2005, KRAS). Low mobility.

**Orchis militaris** L. – *Yatryshnik shlemonosny.*

In sparse birch and mixed forests, on swampy meadows, along damp banks, in shrub thickets. Recorded from herbarium samples: Bkh (1938, Yavorsky, Cherepnin; 1940, Cherepnin, KRAS), Se (Tsvetushi log, 1940, Cherepnin, KRAS), Tm (biostation, 1942, Cherepnin, KRAS). Locations at the northern border of the species distribution.

**Iris humilis** Georgi – *Kasatik nizkiy.*

In meadow steppes, on stony and sandy slopes, rubble talus, steppe meadows. Occasionally found: Oo (Stepanov, KRSU) [17], Vc, Ud, Pk, Ot, Ag (2005, KRAS), Vb (2006, KRAS), Hs (2016, E. Antipova, KRAS). Abundant in places.

**Hemerocallis minor** Mill. – *Krasodnev maly.*

In light birch, birch-pine forests, on forest edges and glades, steppe meadows, in meadow steppes. Occasionally found: Vb, Ud, Pl, Vzh, Bts, Sch, Ag (2005, KRAS). Is not abundant.

**Carex sajanensis** V.I. Krecz. – *Osoka sayanskaya.*

Along the above-floodplain dry sandy areas of the river. Yenisei. Very rare: Oo (1998, Stepanov, KRAS, KRSU) [22]. In the Yenisei Siberia, this is the northernmost locality of the species [13, 14].

**Deschampsia kaschinae** Stepanov – *Shchuchka Kashinoy.*

On damp silted pebbles in the floodplain of the river. Yenisei. Very rare. Collected once along the banks of the river Yenisei near the monastery: Ud (1992, Stepanov, KRSU), from where it is described [16].

**Festuca sibirica** Hack. ex Boiss. – *Ovyanitsa sibirskaya.*
On open stony and gravelly hillsides, along coastal rocky outcrops. It is very rare: Pk (1950, Cherepnin, KRAS) [13, 14].

**Koeleria krylovii** Reverd. – **Tonkonog Krylova**.

On the southern slopes, in meadow steppes, steppe meadows. Herbarium collections from one locality: Se (Tsvetushi Log, 1939, Shvab, Cherepnin, KRAS; 1947, Cherepnin, TK; 1950, Kashina, KRAS).

**Koeleria thonii** Domin – **Tonkonog Tona**.

On open river sands. Very rare: Oo (1997, Stepanov, KRSU) [16].

**Melica altissima** L. – **Perlovnik vysokiy**.

Along the open coastal rocky slopes, rubble talus. It is very rare: Bkh (river Bazaikha, 1937, Yavorsky, Cherepnin, KRAS) [12].

**Melica transsilvania** Schur – **Perlovnik transil’vanskiy**.

On stony steppe slopes and talus. It is very rare: Bkh (1949, Eskova, Cherepnin, KRAS) [12].

**Stipa pennata** L. – **Kovyl’ peristy**.

In meadow steppes, on dry meadows, steppe forest edges, in sparse birch and mixed forests. It is rare: Vc, Ud, Bkh, Zd, Sch, Ns, Ag (2005, KRAS). Abundant in places.

### 4. Conclusion

Having examined the territory of Krasnoyarsk in detail, it is possible to offer for protection the preserved areas of natural forests in the area of Akademgorodok, Nikolaevskaya Sopka, forest areas in the area of Udachny settlement, the hydrological site of the Oktyabrsky lake-park in the area of Myasokombinat, the coast of the river Yenisei, islands, as well as steppe areas with a complex of xerophilous flora. These are urbanophobic plant communities where rare species are found. It is these territories that are not subject to systematic development and the greatest exploitation by the population of the city and are awaiting close attention of nature conservation and environmental organizations [22-25].

In order to bring the regime of protection and nature management in accordance with the statuses of the above species, a transition to the rational use of plant resources in conditions of intensive urbanization is necessary. There are many activities, including:

- identification of all species requiring protection, as well as new locations of these species;
- study of the ecology and biology of rare and endangered plant species;
- complete ban on collection for medicinal and decorative purposes;
- carrying out work to restore lost plant species to enrich the few preserved areas of natural vegetation and enrich the city's vegetation cover by creating various urban plantations for general use (parks, squares), forest shelter belts, restoring lost forests on the city outskirts, etc.;
- strengthening advocacy on the protection, rational use and transformation of the natural environment through various kinds of publications on relevant topics, the organization of ecological trails and excursions for students;

V.B. Kuvaev [24], along with the proposed measures, specifically for the preservation of the urbanized flora, proposes:

- the creation of an artificial refugium (refuge) of flora, concentrating in a limited area, if possible, all types of the urbanized area and its immediate surroundings, both currently growing and growing in the near past;
- creation of natural monuments for the protection of the most interesting and valuable floristically and faunistically areas within the urbanized area.

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