Snakes of the Volga basin in the Red Data Books of Different Levels

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Abstract. Currently, 11 species of snakes are reliably known to be found in the Volga River basin. *Vipera renardi* has been assigned the Vulnerable (VU) category on the IUCN Red List of Threatened Species. The authors analyze the representation of snakes in the Volga basin in the latest editions of the Red Data Book (RDB) of the Republic of Kazakhstan, the RDB of the Russian Federation and the RDBs of Russian Oblasts, which are fully or partially related to the Volga basin. The species *Hierophis caspius* is included in the list of protected species in the RDB of Kazakhstan in the interfluve of the Volga and the Urals. The RDB of the Russian Federation considers rare and threatened three ophidiofauna species of the Volga basin: *Eryx jaculus*, *Eryx miliaris*, and *Elaphe sauromates*. *Coronella austriaca* is the most listed species in the Red Data Books of the constituent entities of Russia in the Volga Basin (35 Red Data Books); it is widespread but rare. The RDB of the Republic of Kalmykia protects the world's northernmost population of *Eryx jaculus*. The RDBs of the Republic of Bashkortostan and Samara Oblast protect the world's northernmost populations of *Natrix tessellata*, the RDB of Tatarstan protects the world's northernmost population of *Vipera berus*. The RDB of Volgograd Oblast protects the world's northernmost population of *Hierophis caspius*, and the RDB of Samara Oblast – the northernmost population of *Elaphe dione* in Europe. Anthropogenic transformation of habitats, traffic-related deaths and actual killing of snakes are the main limiting factors in the RDBs. The authors believe that an effective measure of conservation is the creation of protected areas in the habitats of species, and, first of all, the preservation of winter brumation sites.

1. Introduction
Eleven species of snakes are found in the Volga basin. These species belong to 4 families: the Boidae family is represented by *Eryx jaculus* (Linnaeus, 1758) and *E. miliaris* (Pallas, 1773); the Colubridae – by *Natrix natrix* (Linnaeus, 1758), *N. tessellata* (Laurenti, 1768), *Coronella austriaca* Laurenti, 1768, *Elaphe dione* (Pallas, 1773), *E. sauromates* (Pallas, 1814), *Hierophis caspius* (Gmelin, 1789); Lampropidiidae – by *Malpolon monspessulanus* (Hermann, 1804); Viperidae – *Vipera berus* (Linnaeus, 1758) and *V. renardi* (Christoph, 1861). Many of these reptiles are scarce and rare, and they are included in the IUCN Red List of Threatened Species, RDBs of Kazakhstan, the Russian Federation and the subjects of the Russian Federation, wholly or partially belonging to the Volga basin.

The aim of this study is to analyze the representation of the ophidiofauna species of the Volga basin in the Red Data Books of different levels.
2. Materials and Methods
The basin of the Volga, the largest European river, has a catchment area of about 1.36 million km² on the East European Plain (almost 13% of the area of Europe) and includes 41 administrative units (Perm Krai, administrative oblasts, Moscow). Two of these units (West Kazakhstan and Atyrau oblast) are in Kazakhstan, the rest are in Russia [1]. In a broad herpetological sense, the geographical coordinates of the Volga basin lie between 44° and 63°N, 32° and 61°E, including a number of adjacent territories - Kalmykia (except for the south-west of the republic) and the south of the Volga-Ural interfluve (east of Astrakhan and Volgograd Oblasts in Russia, west of West Kazakhstan and Atyrau Oblasts in Kazakhstan). Herpetologists consider these territories as constituent parts of the Volga basin according to historical data [2].

The study is based on the analysis of open access data on the conservation status of snakes inhabiting the Volga basin. The latest editions of the RDBs are the primary data source.

3. Results and Discussion
Species of Vipera renardi is classified by the IUCN Red List of Threatened Species as Vulnerable (VU) [3]. The rest of the snake species are either not yet included in this list, or have the Least Concern (LC) category.

The RDB of the Republic of Kazakhstan [4] includes two species from the ophidiofauna of the Volga basin: Hierophis caspius (under the name Coluber caspius, category 4 – uncertain status,) and Elaphe sauromates (under the name Elaphe quatuorlineata, category 3 – an insufficiently studied taxa and populations found in a limited area). However, E. sauromates in Kazakhstan is reliably found so far only outside the Volga basin.

The new edition of the Red Data Book of the Russian Federation includes three species of snakes common in the Volga basin – Eryx jaculus, Eryx miliaris and Elaphe sauromates. These three species are categorized the same rarity status category “2 – Decreasing number and/or distribution” and the IUCN category of extinction threat status “VU – Vulnerable” [5].

The snakes of the Volga basin are included in 37 of 39 Red Data Books of the constituent entities of the Russian Federation, fully or partially included in the territory of the Volga basin (table 1). Eryx jaculus is included in the main lists of one Red Data Book, E. miliaris – in 2 Red Data Books, Natrix natrix – in 4, N. tessellata – in 4, Coronella austriaca – in 33, Elaphe dione – in 5, E. sauromates – in 3, Hierophis caspius – in 3, Malpolon monspessulanus – in 2, Vipera berus – 14, and Viperia renardi – in 11.

Snakes are not mentioned in the Red Data Books of the Komi Republic and Smolensk Oblast [6, 7]. Editions of the Red Data Books, published more than 10 years ago (Smolensk, Leningrad and Orel oblasts, the Republic of Mordovia [7-10]), may contain outdated data and currently need to be revised.

Coronella austriaca is the most listed species in the Red Data Books of the constituent entities of Russia in the Volga Basin (found in 35 regions out of 39); it is widespread but rare. This species is included in the main lists of 33 regional Red Data Books [10-43] and in the appendices to two regional Red Data Books [9, 44]. Eryx jaculus is the least listed species in the regional RDBs of the Volga basin. This snake is only found in the Republic of Kalmykia within the territory of the Volga basin [11].

In the Volga basin, the RDB of the Republic of Kalmykia [11] protects the world's northernmost population of Eryx jaculus. The RDBs of the Republic of Bashkortostan [12] and Samara Oblast [13] protect the world's northernmost populations of Natrix tessellata, the RDB of Tatarstan [14] protects the world's northernmost population of Vipera renardi. The RDB of Volgograd Oblast [15] protects the world's northernmost population of Hierophis caspius, and the RDB of Samara Oblast [13] – the northernmost population of Elaphe dione in Europe. Let us doubt the reliability of the data concerning
the modern habitation of *E. sauromates* in Volgograd Oblast at the northern limit of the range, despite the inclusion of the species in the regional Red Data Book [15].

Let us consider the limiting factors provided in the species sketches of the Red Data Books. In the Republic of Kalmykia, the reasons for the decline in the number of *Eryx jaculus* include regular fires, depriving these snakes of shelters, as a result of which they become more visible to predators. The limiting factor is considered to be the reduction in the area of suitable habitats [11]. The number of *E. miliaris* in Kalmykia is negatively affected by the reduction in the area of open sands, and in Astrakhan Oblast – by excessive agricultural methods [16]. *Natrix natrix* is negatively affected by degradation, fragmentation and pollution of suitable habitats, recreational load, traffic-related deaths and actual killing by people [8, 17-19]. Similar reasons apply for *Natrix tessellata*, as well as changes in the water regime, undermining the food supply, and coastal development [12, 13, 20, 21]. The most common factors that have a negative impact on *Coronella austriana* are the following: actual killing by people, since the snake is mistakenly considered venomous, traffic-related deaths and the reduction of suitable habitats [10-17, 25, 33].

For three species of snakes – *Elaphe dione*, *E. sauromates* and *Hierophis caspius* – the following factors are considered to be limiting: economic development of habitats, traffic-related deaths, actual killing by people, overcollection for pet trade [11, 12, 15, 16, 21]. According to the Red Data Book of Kalmykia, for *Malpolon monspessulanus*, habitat reduction associated with the economic development of the territory is disastrous [11]. *Vipera berus* and *V. renardi* are susceptible to targeted destruction by humans since they are venomous snakes. *V. berus* is also negatively affected by anthropogenic development of forest habitats, an increase in the recreational load, drainage of bogs, spring bursts of dry grass, and mechanized haymaking [17, 24, 30]. The threat to *V. renardi* is the development and plowing of lands that are their natural habitats, as well as grazing [11, 21, 23, 29, 44].

Thus, anthropogenic transformation of habitats, traffic-related deaths and actual killing of snakes are the main limiting factors in the RDBs. The authors believe that an effective measure of conservation is the creation of protected areas in the habitats of species, and, first of all, the preservation of winter brumation sites.

The section “Conservation Measures” in the Red Data Books lists measures already taken and proposed measures for the conservation of snakes. We believe that the creation of objects of territorial protection is the most effective possible action. Adding species to protected lists is a necessary but insufficient procedure. We are of the opinion that real protection can be provided by the creation of protected natural areas covering the habitats of rare snakes. First of all, these are various natural locations where snakes can comfortably and safely enter a period of brumation. Such locations are becoming less and less in recent years. For example, not so long ago in Krasnogolinsky district of Samara, one brumation site of *V. berus* was destroyed due to the construction of a parking lot, another – due to the demolition of a metal bridge under which the snakes used to brumate in winter.

**Table 1. Representation of snakes in the Volga basin in the regional Red Data Lists [6-44]**

| Red Data Lists          | *E.j.* | *E.m.* | *N.n.* | *N.t.* | *C.a.* | *E.d.* | *E.s.* | *H.c.* | *M.m.* | *V.b.* | *V.r.* |
|-------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Astrakhan Oblast (2014) | 00     | +      | –      | –      | +      | –      | +      | +      | 00     | +      |        |
| Bryansk Oblast (2016)   | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     |        |
| Chelyabinsk Oblast (2017)| 00    | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     | +      |
| Chuvash Republic (2010) | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     | +      |
| Ivanovo Oblast (2017)   | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     |        |
| Kaluga Oblast (2017)    | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     | +      |
| Kirov Oblast (2014)     | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     |        |
| Komi Republic (2019)    | 00     | 00     | –      | 00     | 00     | 00     | 00     | 00     | –      | 00     | +      |
| Kostroma Oblast (2019)  | 00     | 00     | –      | 00     | +      | 00     | 00     | 00     | –      | 00     |        |


| Region                             | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|-----------------------------------|------|------|------|------|------|------|------|
| Kursk Oblast                       | 00   | 00   | 00   | +    | 00   | 00   | +    |
| Leningrad Oblast                  | 00   | 00   | 00   | +    | 00   | 00   | 00   |
| Lipetsk Oblast                    | 00   | 00   | –    | +    | 00   | 00   | 00   |
| Moscow City (2011)                | 00   | 00   | +    | 00   | 00   | 00   | 00   |
| Moscow Oblast (2018)              | 00   | 00   | +    | 00   | 00   | 00   | 00   |
| Nizhny Novgorod Oblast (2014)     | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Novgorod Oblast (2015)            | 00   | 00   | +    | 00   | 00   | 00   | 00   |
| Orel Oblast (2007)                | 00   | 00   | –    | 00   | ±    | 00   | 00   |
| Orenburg Oblast (2019)            | 00   | 00   | –    | ±    | +    | 00   | 00   |
| Penza Oblast (2019)               | 00   | 00   | –    | 00   | ±    | 00   | 00   |
| Perm Krai (2018)                  | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Republic of Bashkortostan (2014)  | 00   | 00   | –    | +    | +    | 00   | 00   |
| Republic of Kalmykia (2013)       | +    | +    | –    | –    | +    | ±    | 00   |
| Republic of Mari El (2016)        | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Republic of Mordovia (2005)       | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Republic of Tatarstan (2016)      | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Ryazan Oblast (2011)              | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Samara Oblast (2019)              | 00   | 00   | ±    | +    | +    | 00   | 00   |
| Saratov Oblast (2021)             | 00   | 00   | ±    | ±    | +    | ±    | 00   |
| Smolensk Oblast (1997)            | 00   | 00   | –    | 00   | 00   | 00   | 00   |
| Sverdlovsk Oblast (2018)          | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Tambov Oblast (2012)              | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Tula Oblast (2013)                | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Tver Oblast (2013)                | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Udmurtian Republic (2012)         | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Ulyanovsk Oblast (2015)           | 00   | 00   | –    | +    | +    | 00   | 00   |
| Vladimir Oblast (2018)            | 00   | 00   | –    | 00   | +    | 00   | 00   |
| Volgograd Oblast (2017)           | 00   | 00   | –    | 00   | ±    | +    | +    |
| Volgodonsk Oblast (2010)          | 00   | 00   | ±    | 00   | 00   | 00   | 00   |
| Yaroslavl Oblast (2015)           | 00   | 00   | ±    | 00   | +    | 00   | 00   |

Designations: “+” – the species is included in the main list of the regional RDB; “±” – the species is included in the appendix to the regional RDB; “–” - the species is not included in the regional RDB, but reliably lives in this region; “±0” – the species is included in the regional RDB, but at the same time it is found in the region only outside the Volga basin; 00 – the species is not included in the regional RDB and does not reliably inhabit the region; E.j. – *Eryx jaculus*; E.m. – *Eryx miliarius*; N.n. – *Natrix natrix*; N.t. – *N. tessellata*; C.a. – *Coronella austriaca*; E.d. – *Elaphe dione*; E.s. – *E. sauromates*; H.c. – *Hieropis caspius*; M.m. – *Malpolon monspessulanus*; V.b. – *Vipera berus*; V.r. – *Vipera renardi*.

### 4. Conclusion

The snakes of the Volga basin are included in the IUCN Red List of Threatened Species, the RDB of Kazakhstan, the RDB of the Russian Federation and 37 RDBs of the constituent entities of the Russian Federation. In general, these RDBs of various levels include all 11 species of snakes inhabiting the Volga basin. These RDBs protect the world's northernmost populations of *Eryx jaculus, Natrix*.
tessellata, Hierophis caspius, Vipera renardi and the northernmost population of Elaphe dione in Europe. Anthropogenic transformation of habitats, traffic-related deaths and actual killing of snakes are the main limiting factors in the RDBs. The authors believe that an effective measure of conservation is the creation of protected areas in the habitats of species, and, first of all, the preservation of winter brumation sites.

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