(BIO5), and the mean temperatures of the driest (BIO9), warmest (BIO10), and coldest (BIO11) quarters of the year (74%). Among the key parameters for the precipitation variables were April precipitation (81%), annual precipitation (BIO12), precipitation in the wettest month (BIO13), seasonality of precipitation (BIO15), precipitation of the wettest quarter of the year (BIO16) (75%), and May, August, and December precipitation (74%). Temperature and precipitation directly impact the physiological activity of the salamander and/or regulate the onset and manifestation of its phenological phenomena (spring awakening, egg-laying, larval growth and development, hibernation, etc.).

The analysis of relief and climate contribution to EN formation reveals a close interrelation between the two factors. The origin of every watercourse, its hydrological parameters, and microhabitat diversity are determined by local microrelief and microclimate. This gives us cause to talk about oroclimatic and orohygrographic factors. Among the climatic factors, the model accorded greater weight to precipitation than to temperature. Since the precipitation mode in mountain regions strongly depends upon relief we consider the last as a very important abiotic factor defining the spatial and numerical distribution of the species.

The analysis of climatic variables of the ENM confirmed the previous assumption on glacier mass stability and steadiness of the annual runoff of mountain watercourses as important conditions for *R. sibiricus*'s well-being. Among the key variables of the EN were mean summer temperatures (BIO11), annual precipitation (BIO12), precipitation of the wettest quarter of the year (BIO16), and August precipitation — required to maintain the glacier mass balance.

The results of the EN modeling gave us a reason to discuss critically early ideas on *R. sibiricus in situ* conservation. According to the ENM, the current orographic and climatic conditions of sublongitudinal rivers flowing from the Northern Central Ridge, Usek-Khorgos, region and Northern Tien Shan are not suitable for the species in many aspects. It seems more realistic to search the sites in sublatitudinal river valleys. Concomitant analysis of current climatic conditions and their future changes under global warming and glacier degradation is necessary. The present instability of the climate in the Dzungarian Alatau determines the reality of species *ex situ* conservation as well.

We consider the ENM that we created as a primary and basic pattern because of limits set on the analysis. We considered only abiotic factors such as relief and climate and not all of the variables important for *R. sibiricus*'s life cycle, for example, the presence of permanent and temporary water streams inside the suitable area or water chemistry. We also did not touch on biotic factors like the abundance of food or relations with competitor and enemy species. This enumeration can be continued further in accordance with the understanding of the ecological niche as an *n*-dimensional abstract space, each axis of which corresponds to a certain parameter (Hutchinson, 1957).

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REFERENCES

Akhmedsafin U. M., Dzabasov M. Kh., Shlygina V. F., Oshlakov G. G., Levinsky Yu. N., and Mirlas V. M. (1975), "Taldy-Kurgan oblast'," in: *Hydrogeological Conditions of Kazakhstan*, Nauka, Alma-Ata, 90 – 103 [in Russian].

Averianov O. A. and Tjutkova L. A. (1995), "*Ranodon* cf. *sibiricus* (Amphibia, Caudata) from the Upper Pliocene of Southern Kazakhstan: the first fossil record of the family Hynobiidae," *Palaontol. Zeitschr.*, **69**(1/2), 257 – 264.

Baker B., Diaz H., Hargrove W., and Hoffman F. (2010), "Use of the Köppen-Trewartha climate classification to evaluate climatic refugia in statistically derived ecoregions for the People's Republic of China," *Climatic Change*, **98**, 113 – 131. DOI: 10.1007/s10584-009-9622-2.

Bannikov A. G. (1949), "On the biology of *Ranodon sibiricus*," *Dokl. AN SSSR*, **65**(2), 237 – 240 [in Russian].

Barry R. (2008), *Mountain Weather and Climate. 3rd Edition*, Cambridge Univ. Press, New York.

Berman D. I. (2002), "Ideal adaptator, or adaptive strategy of the Siberian Salamander," *Priroda*, **3**, 59 – 68 [in Russian].

Blaga L. (2012), "Aspects regarding the significance of the curvature types and values in the studies of geomorphometry assisted by GIS," *Anal. Univ. Oradea Ser. Geogr.*, **2012**, 327 – 337, http://istgeorelint.uoradea.ro/Reviste/Anale/anale.htm.

Borisevich D. V. (1958), "Experience in genetic classification of the landforms," *Nauch. Zap. MGPI im. V. I. Lenina. Geogr.*, **120**(3), 43 – 57 [in Russian].

Borkin L. J. and Litvinchuk S. N. (2011), "On Turkestan Salamander *Hynobius turkestanicus* Nikolsky, 1910 and Vasily Nikolsky's Pamirs travel," *Curr. Stud. Herpetol.*, **11**(3/4), 103 – 120 [in Russian].

Brodsky K. A. (1976), *The Mountain Flow of Tien Shan*, Nauka, Leningrad [in Russian].

Brushko Z. K. (1993), "Dynamics of number, distribution of Siberian Salamander and the problems of its protection," *Ékologiya*, No. 3, 84 – 87 [in Russian].

Brushko Z. K. and Dujsebayeva T. N. (2009), "Siberian Salamander (*Ranodon sibiricus*)," *Selevinia*, **17**(1), 24 – 34 [in Russian].

Brushko Z. K. and Narbayeva S. P. (1988), "Breeding of Siberian Salamander in the Borokhudzir River Valley (Southeastern Kazakhstan)," *Ékologiya*, No. 2, 45 – 49 [in Russian].

Brushko Z. K., Kubykin R. A., and Narbayeva S. P. (1988), "Recent distribution of Siberian Salamander *Ranodon sibiricus* (Amphibia, Hynobiidae) in Dzhungar Alatau," *Zool. Zh.*, **63**(1), 1753 – 1755 [in Russian].

Chen D. and Chen H. (2013), "Using the Köppen classification to quantify climate variation and change: an example for 1901 – 2010," *Environm. Devel.*, **6**, 69 – 79. DOI: 10.1016/j.envdev.2013.03.007.

Chen S.-Y., Zhang Y.-J., Wang X.-L., Sun J.-Y., Xue Y., Zhang P., Zhou H., and Qu L.-H. (2012), "Extremely low genetic diversity indicating the endangered status of *Ranodon sibiricus* (Amphibia: Caudata) and implications for phylogeography," *PLoS ONE*, **7**(3), e33378. DOI: 10.1371/journal.pone.0033378.

Cherednichenko A. V., Cherednichenko Al. V., and Cherednichenko V. C. (2013), *The Time Series of the Temperature and Precipitation*, Mega Print, Almaty [in Russian].

Cherkasov P. A. (2004), *Calculation of Components of Water-Ice Balance in Inland Ice System*, Kaganat Publ. Co., Almaty [in Russian].

De Castro M., Gallardo C., Jylha K., and Tuomenvirta H. (2007), "The use of a climate-type classification for assessing climate change effects in Europe from an ensemble of nine regional climate models," *Climate Change*, **81**(Suppl.), 329 – 341. DOI: 10.1007/s10584-006-9224-1.

Didenko-Kislitsina L. K. (1965), "On the age and area of Jungarian Alatau glaciers," in: *Glacialogical Studies in Kazakhstan*, Nauka, Alma-Ata, No. 5, pp. 135 – 155 [in Russian].

Didenko-Kislitsina L. K. (2001), *Cenozoic of Southeastern Kazakhstan: Physiography Essay. I. Stratigraphy, Paleogeography. 2nd Edition*, MRK Publ. Co., Almaty [in Russian].

Doronin I. V. (2015), "Distribution data of rock lizards from the *Darevskia* (*praticola*) complex (Sauria: Lacertidae)," *Curr. Stud. Herpetol.*, **15**(1/2), 3 – 38.

Dujsebayeva T. N. (2013), "Results of monitoring of *Ranodon sibiricus* Kessler, 1866 (Amphibia: Caudata: Hynobiidae) populations in the southern part of the area," *Tr. Zool. Inst. RAN*, **317**(2), 151 – 175 [in Russian].

Dujsebayeva T. N., Malakhov D. V., and Cherednichenko A. V. (2014), "The prognosis of area dynamics for rare amphibian species under climatic change scenario," in: *Mater. 1st Int. Sci. Pract. Conf.* "*Desertification of Central Asia*: *Assessment*, *Forecast*, *Management*," Astana, September 25 – 27, 2014, Astana, pp. 206 – 211 [in Russian].

Dujsebayeva T. N., Burdelov L. A., Timirkhanov S. R., Krupa E. G., Berezovikov N. N., Kadyrbekov R. Kh., and Childebayev M. K. (2015), "Prognosis of possible changes in animal world of Kazakhstan under global warming, aridization and desertification," in: *Int. Conf.* "*Ecosystems of Central Asia under current conditions of socio-economic development*," *Ulaanbaatar*, *September 8 – 10*, *2015*, *Vol. 2*. Ullanbaator, pp. 356 – 360.

Dzakelov A. K. and Bazarbayeva G. O. (2012), "The patterns of formation of underground waters of Zailiysky Alatau," *Izv. NAN RK Ser. Geol. Tekh. Nauk*, **5**, 38 – 44 [in Russian with English abstract].

Edelshtein Ya. S. (1947), *Basic Geomorphology*: *Brief Course. 2nd Edition*, Gosizdat Mingeologii SSSR, Moscow – Leningrad [in Russian].

Fujita K., Takeuchi N., Nikitin, S. A., Surazakov A.B., Okamoto S., Aisen V. B., and Kubota J. (2011), "Favorable climatic regime for maintaining the present-day geometry of the Grigoriev Glacer, Inner Tien Shan," *Cryosphere*, **5**, 539 – 549. DOI: 10.5194/tc-5-539-2011.

Gerasimov I. P. (1959), *Structural Features of Relief in USSR and the Origin of Relief Features*, Izd. AN SSSR, Moscow [in Russian].

Goloskokov V. P. (1984), *Flora of Junggarian Alatau*: *Summary and Analysis*, Nauka, Alma-Ata [in Russian].

Gorbunov A. P., Seversky E. V., and Titkov S. N. (1996), *Geocryological Peculiarities of Tien Shan and Pamir*, Permafrost, Inst. SO RAN, Yakutsk [in Russian].

Graham C. H. and Hijmans R. J. (2006), "A comparison of methods for mapping species ranges and species richness," *Global Ecol. Biogeogr.*, **15**, 578 – 587.

Groff L. A., Mark, S. B., and Hayes M. H. (2014), "Using ecological niche models to direct rare amphibian surveys: a case study using the Oregon Spotted Frog (*Rana pretiosa*)," *Herpetol. Conserv. Biol.*, **9**(2), 354 – 368.

Heatwole H. (1983), "Physiological responses of animals to moisture and temperature", in: F. D. Golley (ed.), *Tropical Rainforest Ecosystems*, *Structure and Function. Ecosystems of the World*. Vol. 14A, Elsevier Scientific Publishing Co., New York, pp. 239 – 265.

Hutchinson G. E. (1957), "Concluding remarks, Cold Spring Harbor Symposia on Quantitative Biology," *Bull. Math. Biol.*, **22**, 415 – 427; reprinted in 1991: "Classics Theoretical Biology," *Bull. Math. Biol.*, **53**, 193 – 213.

Isachenko A. G. (1985), *Landscapes of USSR*, Izd. LGU, Leningrad [in Russian].

Kabak I. I. (2014), "Boundaries of zoochorones in Northern Xinjiang exemplified for Carabid-beetles (Coleoptera, Carabidae)," in: *Proc. Int. Symp. on Biol. Resour. Protect., and Manag. in the Arid Central Asia, Urumqi, Xinjiang, September, 2014*, Urumqi, Xinjiang, pp. 4 – 6.

Kalesnik S. V. (1932), "By Junggarian Alatau]," *Izv. Vsesoyuz. Geogr. Obshch.*, **64**(2 – 3), 172 – 180 [in Russian].

Khromov S. P. and Petrosyants M. A. (2006), *Meteorology and Climatology: Textbook. 7th Edition*, Izd. MGU – Nauka, Moscow [in Russian].

Kostenko N. P. (1970), *Relief Development of the Highland* (*on the Example of Middle Asia*), Mysl', Moscow [in Russian].

Kostenko N. P. (1975), *Quaternary Deposits of Highlands*, Nedra, Moscow [in Russian].

Kottek M., Grieser J., Beck C., Rudolf B., and Rubel F. (2006), "World Map of the Köppen-Geiger climate classification updated," *Meteorol. Zeitschr.*, **15**(3), 259 – 263.

Kuzmin S. A. (2012), *Amphibians of the Former USSR*, KMK, Moscow [in Russian].

Kuzmin S.L. and Thiesmeier B. (2001), "Mountain salamanders of the genus *Ranodon*," in: *Advances in Amphibian Research in the Former Soviet Union. Vol. 6*, Pensoft, Sofia – Moscow.

Kuzmin S.L., Kubykin R. A., Thiesmeier B., and Greven H. (1998), "The distribution of the Semirechensk Salamander (*Ranodon sibiricus*): a historical perspective," in: *Advances in Amphibian Research in the Former Soviet Union. Vol.* 3, Pensoft, Sofia – Moscow, pp. 1 – 20.

Kuzmin S., Wang X., Ishchenko V., and Tuniyev B. (2004), "*Ranodon sibiricus*," in: *The IUCN Red List of Threatened Species 2004*, e.T19304A8851144. DOI: 10.2305/iucn.uk. 2004.rlts.t19304a8851144.en, downloaded on 27 January 2016.

Litvinchuk S. N., Kazakov V. I., Pasynkova R. A., Borkin L. J., Kuranova V. N., and Rosanov J. M. (2010), "Tetraploid green toad species (*Bufo pewzowi*) from the Altay Mountains: the first record for Russia," *Rus. J. Herpetol.*, **17**(4), 290 – 298.

Malakhov D. V. and Dujsebayeva T. N. (2014), "High endemism of *Ranodon sibiricus* (Amphibia: Urodela: Hynobiidae): evidences from GIS and Remote Sensing Data," in: *Proc. Int. Symp. on Biol. Resour. Protect., and Manag. in the Arid Central Asia, Urumqi, Xinjiang, September, 2014*, Urumqi, Xinjiang, pp. 6 – 7.

Mamedov G. M. and Novikov I. S. (2015), "Geomorphology of the Dzhungarian Plain and its mountain frame," *Geomorfologiya*, No. 1, 88 – 100 [in Russian].

Murzayev E. M. (1966), *Nature of Xinjiang and Formation of Central Asian Deserts*, Nauka, Moscow [in Russian].

Osokin N. I. and Sosnovsky A. V. (2015), "Impact of dynamics of air temperature and snow cover thickness on the ground freezing," *Kriosfera Zemli*, **XIX**(1), 99 – 105 [in Russian].

Paraskiv K. P. (1953), "Semirechensk Newt," *Izv. AN KazSSR Ser. Biol.*, **8**, 47 – 56 [in Russian].

Peel M. C., Finlayson B.L., and McMahon T. A. (2007), "Updated world map of the Köppen-Geiger climate classification," *Hydrol. Earth Syst. Sci.*, **11**, 1633 – 1644; http://www.hydrol-earth-syst-sci.net/11/1633/2007.

Penman T. D., Mahony M. J., Towerton A. L., and Lemckert F. L. (2007), "Spatial models of giant burrowing frog distributions," *Endang. Species Res.*, **3**, 115 – 124.

Pidwirny M. (2011), *Moist Continental Mid-latitude Climates – D Climate Type*, http://www.eoearth.org/view/article/162285.

Podrezov O. A. (2014), *Mountain Climatology and Altitudinal Climatic Zonation of Kyrgyzstan*, Kyrgyz State Univ. Publ., Bishkek [in Russian].

Raffaëlli J. (2013), *Les Urodèles du Monde*, Penclen Edition.

Rautian A. S. (2003), "On the base evolutionary theory of multispecies communities and about its author," in: G. Yu. Lubarsky, K. G. Mikhailov, and A. P. Rasnitsin (eds.), *Selected Works on Paleoecology and Phylocenogenetics*, KMK, Moscow, pp. 1 – 42 [in Russian].

Raxworthy C. J., Ingram C. M., Rabibisoa N., and Pearson R. G. (2007), "Applications of ecological niche modeling for species delimitation: a review and empirical evaluation using day geckos (*Phelsuma*) from Madagascar," *Syst. Biol.*, **56**(6), 907 – 923.

Ray N., Lehmann A., and Joly P. (2002), "Modeling spatial distribution of amphibian populations: a GIS approach based on habitat matrix permeability," *Biodiv. Conserv.*, **11**, 2143 – 2165.

Sakai A., Nuimura T., Fujita K., Takenaka S., Nagai N., and Lamsal D. (2015), "Climate regime of Asian glaciers revealed by GAMDAM glacier inventory," *The Cryosphere*, **9**, 865 – 880, www.the-cryosphere.net/9/865/2015; DOI: 10.5194/tc-9-865-2015.

Selivanov E. I. (1965), *Geomorphology of Junggaria*, Nedra, Moscow [in Russian].

Seversky I. V. and Seversky E. V. (1990), *Snow Cover and Seasonal Soil Freezing in Northern Tien Shan*, Permafrost. Inst. SO AN SSSR, Yakutsk [in Russian].

Seversky I. V., Kokarev A. L., Seversky S. I., Tokmagambetov T. G., Shaganova L. B., and Shesterova I. N. (2006), *Contemporary and Prognostic Changes of Glaciation in Balkhash Lake Basin*, VAC Publ. House, Almaty.

Severtsov N. A. (1873), "Vertical and horizontal distribution of Turkestan animals," *Izv. Mosk. Imp. Obshch. Lyubit. Estestvozn. Antropol. Ėtnograf.*, **8**(2), 1 – 157 [in Russian].

Sharaya L. S. and Shary P. A. (2004), "Elementary forms in classifications of relief and their relationship to the characteristics of the landscape of Prioksko-Terrasny Reserve," *Izv. Samar. Nauchn. Tsentra RAN*, **1** (Special Issue "Nature Heritage of Russia), 102 – 111 [in Russian].

Shary P. A. (2006), "Geomorphometry in Earth sciencies and ecology, an overview of methods and applications," *Izv. Samar. Nauchn. Tsentra RAN. Biol. Ékol.*, **8**(2), 458 – 473 [in Russian with English summary].

Shnitnikov V. N. (1913), "Some data on Semirechensk Newt (*Ranidens sibiricus* Kessl.)," *Ezhegod. Zool. Muz. Akad. Nauk*, **18**(53), 53 – 61 [in Russian].

Sosedov I. S., Tokmagambetov G. A., and Zenkova V. A. (1982), "Glacial river runoff in the Northern slope of Junggarian Alatau," in: *Dynamics of Natural Processes in Plains and Mountains of Kazakhstan*, Nauka, Alma-Ata, pp. 169 – 178 [in Russian].

Sosedov I. S., Filatova L. N., Kiktenko O. V., Galster N. V., and Assanov E. N. (1984), *Water Balance and Water Resources of the Northern slope of Junggarian Alatau*, Nauka, Alma-Ata [in Russian].

Suzuki N., Olson D. H., and Reilly E. C. (2007), "Developing landscape habitat models for rare amphibians with small geographic ranges: a case study of Siskiyou Mountains salamanders in the western USA," *Biodiv. Conserv.*; DOI: 10.1007/s10531-007-9281-4.

Svarichevskaya Z. A. (1965), *Geomorphology of Kazakhstan and Middle Asia*, Izd. LGU, Leningrad [in Russian].

Tarkhnishvili D., Kaya U., Gavashelishvili A., and Serbinova I. (2008), "Ecological divergence between two evolutionary lineages of the Caucasian salamander: evidence from GIS analysis," *Herpetol. J.*, **18**, 155 – 163.

Tarkhnishvili D., Serbinova I., and Gavashelishvili A. (2009), "Modelling the range of Syrian spadefoot toad (*Pelobates syriacus*) with combination of GIS-based approaches," *Amphibia–Reptilia*, **30**, 401 – 412.

Tsigelnaya I. D. and Golubev G. N. (1963), *Conditions of Slope Runoff Formation*, Izd. AN Kirgiz SSR, Frunze [in Russian].

Vilesov E. N. and Morozova V. I. (2008), "Estimation of glaciers recent conditions in Chinese portion of Junggarian Alatau," in: *Problems of Geography and Geoecology. Vol. 1*, pp. 11 – 18 [in Russian].

Vilesov E. N. and Uvarov V. N. (2001), *Evolution of Zailiskiy Alatau Glaciation in 20th Century*, Kazakh State Univ. Press, Almaty [in Russian].

Vilesov E. N., Guzhavina E. A., and Uvarov V. N. (1986), "On the continentality of climate in Kazakhstan," in: *Problems of Hydrology of Irrigable Soils of Kazakhstan*, Kazakh State Univ. Press, Alma-Ata, pp. 44 – 54 [in Russian].

Vilesov E. N., Morozova V. I., and Seversky I. V. (2013), *Glaciation of Jungar* (*Zhetysu*) *Alatau*: *Past*, *Present*, *Future*, Kazakh State Univ. Press, Almaty [in Russian].

Wang X. and Bai Y. (2000), "Distribution, biology and conservation of *Ranodon sibiricus*," *Sichuan J. Zool.*, **19**, 146 – 148.

Wang X., Ma L., Wu M., Liu M., and Hou L. (1992), "Study on Xinjiang Salamander (*Ranodon sibiricus*) in Wenquan, Xinjiang," in: *Foreign Animal Husbandry – Herbivorous Livestock*, Biol. Suppl., Urumqi, pp. 62 – 64 [in Chinese].

Yuan G. Y. and Zhang L. (2006), "Research on *Ranodon sibiricus* Kessler living conditions and imminent danger degree and protection," *Environm. Protect. Xinjiang*, **28**, 19 – 21.

Zhandayev M. Zh. (1960), "Morphological structure of Chilik River Valley," in: *Problems of Geography of Kazakhstan. Vol. 6*, Izd. AN KazSSR, Alma-Ata, pp. 199 – 204 [in Russian].

Zhandayev M. Zh. (1972), *Geomorphology of Zailiskiy Alatau and the Problem of River Valleys Formation*, Nauka, Alma-Ata [in Russian].

Zhandayev M. Zh. (1984), *River Valleys*, Nauka, Alma-Ata [in Russian].

Zhukova V. K. and Rakovskaya E. M. (2004), *Methods of Complex Physical-Geographical Studies*, Akademiya, Moscow [in Russian].