**BIODIVERSITAS**
Volume 19, Number 1, January 2018
Pages: 202-207

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d190127

# Short Communication: Distribution of dragonflies (Odonata: Insecta) in South Ural lakes, Russia

**IRINA V. MASHKOVA♥, TATYANA G. KRUPNOVA♥♥, ANASTASIYA M. KOSTRYUKOVA♥♥♥, NIKITA E. VLASOV**

Department of Chemistry, South Ural State University. 76 Lenin Prospect, 454080, Chelyabinsk, Russia. Tel./fax.: +7-351-2679517,
♥email: mashkovaiv@susu.ru, ♥♥ krupnovatg@susu.ru, ♥♥♥ kostriukovaam@susu.ru

Manuscript received: 8 November 2017. Revision accepted: 27 December 2017.

**Abstract.** *Mashkova IV, Krupnova TG, Kostryukova AM, Vlasov NE. 2018. Short Communication: Distribution of dragonflies (Odonata: Insecta) in South Ural lakes, Russia. Biodiversitas 19: 202-207.* This paper studies the diversity and distribution of Odonata (Insecta) in the South Urals region lakes such as Lake Large Miassovo, Lake Small Miassovo, Lake Ilmenskoe, Lake Savelkul and Lake Baraus. We revised dragonflies in five lakes during May-September 2014-2016. Dragonflies and larvae were identified up to the species. As results, 36 species (12 Zygoptera and 22 Anisoptera) belonging to 15 genera were recorded. To compare the similarities of dragonfly communities of different lakes we used the Canonical Correspondence Analysis (CCA) according the Jaccard index. Comparing the number of records of odonate species for selected lakes in our study, we found that the small richness of species was typical for lakes Savelkul and Baraus (22% and 25% of the total number of species, respectively) and the large values of the species richness was obtained for lakes Small Miassovo, Ilmenskoe and Large Miassovo (50%, 72%% and 80% of the total number of species, respectively).

**Keywords:** Diversity, dragonflies, lake, larvae

## INTRODUCTION

Dragonflies are widely used as bioindicators of different types of water bodies, as they are sensitive to the effect of environmental factors (Bonifait and Villard 2010, Buczyński et al. 2017; Nasirian and Irvine 2017). A large number of works dealing with the use of the richness and the abundance of Odonata as a tool for assessing the anthropogenic impact on the territories and the effectiveness of the created protected areas (Maynou et al. 2017; Silva et al. 2010; Simaika and Samways 2010; Kutcher and Bried 2014). Whereas Odonata lives both in the aquatic environment (larval stage) and in the terrestrial environment (imago stage), they do not only reflect well the changes in the characteristics of the aquatic habitat, but also the land areas adjacent to the water body (Balzan 2012). The surrounding terrain landscape and ground vegetation provide the resources and conditions necessary for the imago preservation (Balzan 2012). In particular, dragonflies have been successfully used in some studies on monitoring the ecosystem restoration (Kadoya et al. 2008; Mabry and Dettman 2010; Magoba and Samways 2010; Elo et al. 2015).

Eutrophic water bodies of the Forest Zone of the South Urals are characterized by a high biological productivity and a richness of amphibious insects, including dragonflies (Popova and Haritonov 2008), which occupy a significant place in the population of both aquatic and land animals. Their adaptive abilities, abundance in aquatic and near-water biocenoses and high morphological specialization distinguish them from other winged insects. A high diversity of landscapes in the South Urals (mountains and plains, forests and steppes), as well as an abundance of water bodies and streams, create a favorable background for the formation of a rich dragonfly fauna. The abundance of dragonflies is high due to the features of the South Ural region water bodies. They have shallow areas where aquatic plants are growing in abundance. It creates favorable conditions for the development of dragonfly larvae. A high productivity of aquatic biocenoses provides an almost unlimited food base for dragonfly larvae.

The history of study the dragonfly fauna of the South Urals originates from Bartenev's scientific expeditions to the South Urals in 1906 (Popova and Haritonov 2008). Over the 100-year study period, most of the localities give a rich comparative material. A comparison of the faunistic lists of the same South Urals regions over different periods of time has shown that the interannual differences in the composition and structure of odonatofauna can be compared with significant interregional differences (Popova and Haritonov 2008).

The biodiversity of dragonflies in South Ural is an important indicator for the monitoring of environmental changes (such as climate change, including global warming, air pollution, various types of invasions). Revision of the South Urals region dragonflies was not conducted the last 10 years. The aim of this work was to study the biodiversity of dragonflies of the five South Urals region lakes.

## MATERIALS AND METHODS

### Study area

The studied water bodies are a part of the Kisegach-Miass hydrological system, which is an almost closed ring consisting of ten large and medium lakes connected by small rivers and brooks. Lake Large Miassovo, Lake Savelkul, and Lake Baraus are located on the territory of the Ilmen State Reserve and can be considered conditionally undisturbed, while Lake Small Miassovo and Lake Ilmenskoe are partially located beyond its borders, only a part of the coastline is in the protected area. These two lakes are exposed to the anthropogenic impact in the form of an additional eutrophying factor associated with the presence of rural settlements and recreation centers in the coastal area.

The lakes of the Ilmen group are small and medium by the area, and medium and deep by the depth. By the chemical composition of the lake water, they refer to hydrocarbonate, calcium and magnesium water of various types. The pH varies depending on the season, in the epilimnion from May to September it varies between 8.0-8.6. The lakes are characterized by a low mineralization of water, i.e., 0.1-0.3 g/L, with the predominance of hydrocarbonate ions and a rich microelement water composition (Krupnova 2014; Krupnova 2017).

By the type of the trophic nature the lakes belong to (Snitko and Snitko 2013; Krupnova 2014): Lake Savelkul is oligotrophic, Lakes Large and Small Miassovoe, Lake Ilmenskoe, Lake Baraus are mesotrophic.

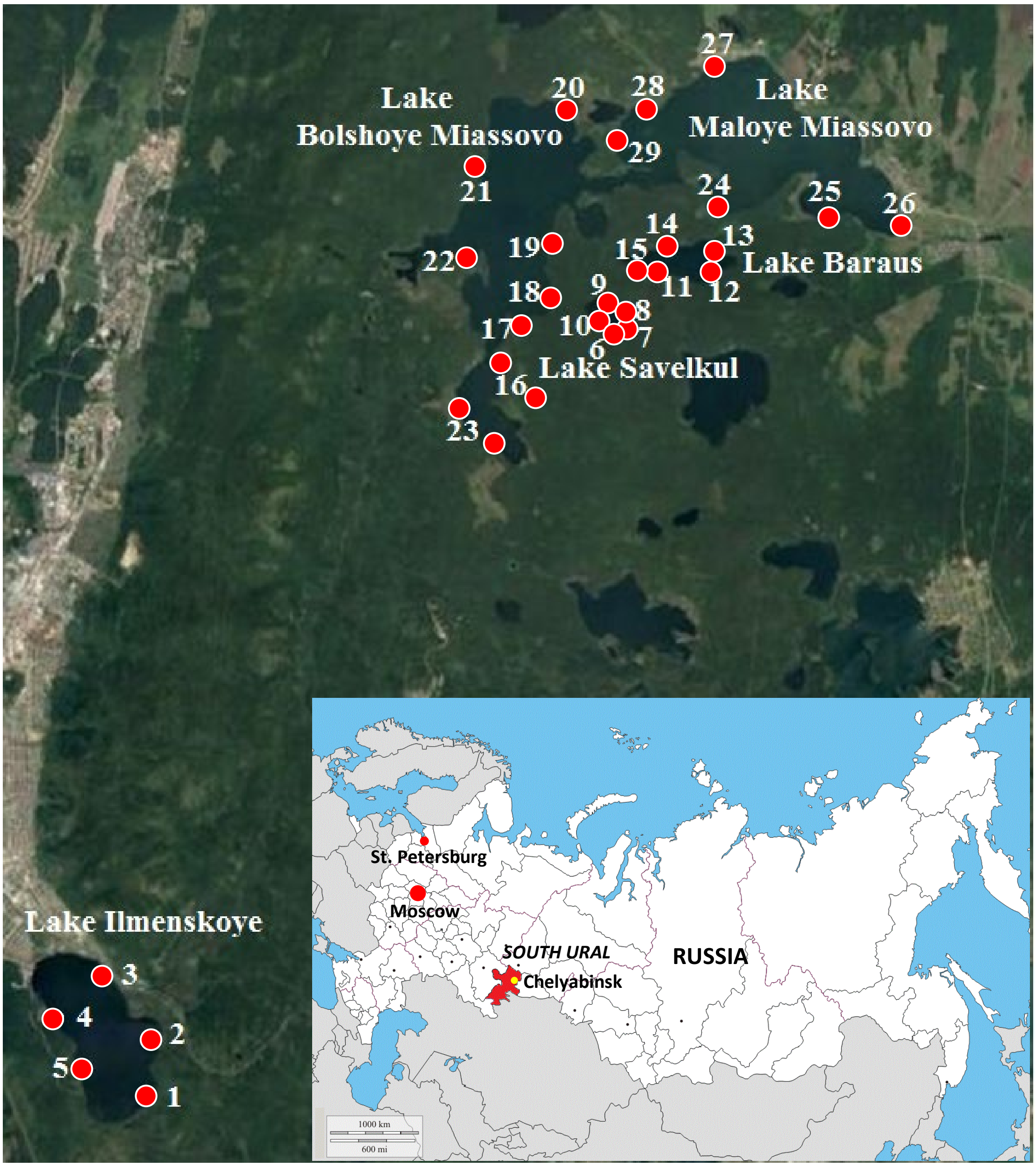


**Figure 1**. Map of lakes and sampling sites of dragonflies (Odonata: Insecta) in South Ural lakes, Chelyabinsk, Russia

**Sampling sites**

The dragonfly population was studied over the period from May to September in 2014-2016 in the water area of Lake Large Miassovo, Lake Small Miassovo, Lake Ilmenskoe, Lake Savelkul and Lake Baraus (Figure 1). Since the aquatic and semi-aquatic vegetation plays a leading role in the life cycle of Odonata and macrophytes are the basis for the habitat of dragonflies (Balzan 2012), the choice of the sites was focused on the plant communities.

**Study of the coastal vegetation**

The description of the vegetation of the studied areas consisted of two 10-meter band routes 1 m wide above the coastal vegetation on the boundary between the land and the water. In addition, four 5 m profiles were laid at the distance of 1 m from each other, perpendicular to these routes in order to understand how the vegetation changes with an increase of the distance from the water bodies.

**Quantitative evaluation of the landscape pattern**

The landscape surrounding the studied lakes was surveyed using orthophotos with a spatial resolution of 15 cm taken in 2014. The lake landscapes of the Kisegach-Miassovskoye hydrological system are similar in many respects, given the proximity of their location, but as for the effect of the anthropogenic factor, there are certain differences. Landscaping metrics were obtained from Patch Analyst 4, ArcGIS resolution, which allows to carry out a spatial analysis of landscape patches (Rempel 2008).

**Odonate sampling**

We caught adult dragonflies using butterfly nets. Five people walked a 200 m transect within 2 meters from the water edge during the coastal locations survey. During sunny weather, between 10 am and 2 pm. We looked out for dragonflies in flight over the water. Once all dragonflies spotted in a location had been caught, we moved on. We re-surveyed the same sites ten times during May to September 2014-2016.

Odonata larvae were collected from May to September 2014-2016. The standardized sampling methodology for collecting larval stages consisted of five samples from 1 $m^2$ area using a rectangular dredging network (200 x 450 mm) with the mesh net of 1 mm. Considering the importance of water macrophytes, which provide sites for laying of adult dragonflies and habitats for larval stages of some species, each visit to the site consisted of three standardized 1 m walkways between vegetation thickets and two other samplings made inside the water body on open sites free from vegetation. The collected benthos was washed with tap water and filtered using a set of sieves with a decrease in the cell size (up to 0.5 mm). All the samples were sorted within 24 hours after collection, and the collected samples were stored in a 70% ethanol solution.

We identified adult dragonflies and larvae using a light microscope and with reference to keys and literature for the region (Mamaev et al. 1976, Balyshev 1977). Also, we used the material of our own collections, as well as analyzed the collection material of the Museum of the Ilmen State Reserve (collections of odontological expeditions).

**Data analysis**

We analyzed the data calculating the similarity on the basis of the Jacquard coefficient as an index of generality. All the calculations were performed using a "GRAPHS" special program module (Nowakowski 2004).

## RESULTS AND DISCUSSION

**Coastal vegetation and landscape in the sites**

The entire surveyed water area is divided into types of coastal vegetation (aquatic biotopes): open water areas with and without submerged vegetation, littoral overgrown with reed, bays with and without submerged vegetation, swamps. By the selectivity of dragonfly imago of various landscape elements within the land borders, the following elements were allocated: bushes, edges, and glades of the mixed light-coniferous and/or small-leaved forests, moist and dry steppe-meadows, birch-aspen forest and forest roads.

Table 1 shows the characteristics of the sites by the types of coastal vegetation and landscape. Table 1 shows that Savelkul and Baraus are lakes with a low diversity of landscapes. Lakes Large and Small Miassovo and Lake Ilmenskoe are characterized by a high diversity of landscapes. Lakes Savelkul and Baraus are also characterized by the predominance of open water areas, and lakes Large and Small Miassovo and Ilmenskoe have a part of swamps vegetation.

**Dragonflies species**

The fauna of dragonflies of the studied territory is heterogeneous in composition and includes a significant percentage of species that find their habitat boundaries or their sites in this region isolated from the main habitats. Assessment of 5 lakes viz., Large Miassovo, e Small Miassovo, Ilmenskoe, Savelkul, and Baraus revealed the occurrence of 36 species of Odonata (22 species of Anisoptera and 12 species of Zygoptera) belonging to 15 genera (Table 2).

**Richness of species and evaluation of similarities in studied lakes**

The smallest richness of species is typical (Figure 2) for lakes Savelkul and Baraus (22% and 25% of the total number of species, respectively). This is despite their considerable distance from the anthropogenic impact and a significant difference in trophicity. Considerable large values of the species richness have been obtained for lakes (Figure 2): Small Miassovo, Ilmenskoe and Large Miassovo, i.e., 50%, 72% and 80% of the total number of species, respectively. Also, the larger the perimeter of the reed beds and wetlands (Table 2), the greater the richness of species. This is due to the fact that more favorable conditions for the development of larvae are created in wetlands and reed beds.

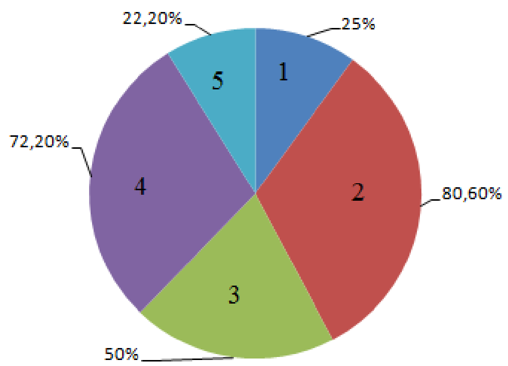


**Figure 2**. Biodiversity of dragonflies of the studied lakes as a percentage of the total number of recorded species. 1. Lake Baraus, 2. Lake Large Miassovo, 3. Lake Small Miassovo, 4. Lake Ilmenskoe, 5. Lake Savelkul

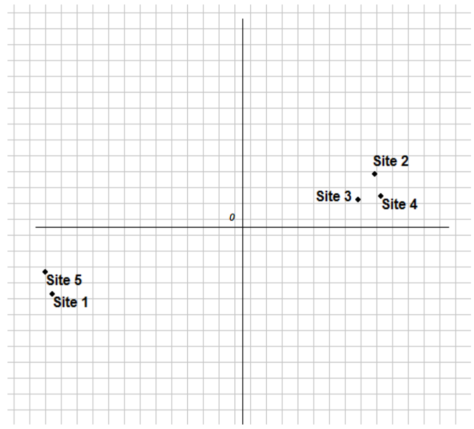


**Figure 3**. Jaccard index

**Table 1**. The coordinates, types of coastal vegetation and landscape of sites in South Ural lakes, Russia

| Sites | | Coastal vegetation type | Landscape type |
|---|---|---|---|
| **Lake Ilmenskoe** | | | |
| Site1 | 54°59'40.48" N, 60°9'44.35" E | Open water area with submerged vegetation | Bushes |
| Site 2 | 55°0'17.20" N, 60°9'56.03" E | Open water area without submerged vegetation | Glade of small-leaved forest |
| Site 3 | 55°1'2.40" N, 60°8'53.64" E | Open water area without submerged vegetation | Forest road |
| Site 4 | 55°0'25.58" N, 60°8'6.05" E | Littoral overgrown with reed | Steppe-meadow |
| Site 5 | 54°59'53.01" N, 60°8'29.97" E | Swamp | Moist meadow |
| **Lake Savelkul** | | | |
| Site 6 | 55°7'54.65" N, 60°18'40.33" E | Open water area without submerged vegetation | Edges of light-coniferous forest |
| Site 7 | 55°8'7.63" N, 60°18'40.43" E | Open water area without submerged vegetation | Glade of the mixed light-coniferous and small-leaved forests |
| Site 8 | 55°8'18.33" N, 60°18'17.00" E | Open water area with submerged vegetation | Bushes |
| Site 9 | 55°7'58.54" N, 60°18'12.50" E | Open water area with submerged vegetation | Glade of the mixed light-coniferous and small-leaved forests |
| Site 10 | 55°7'58.52" N, 60°18'21.34" E | Bay with submerged vegetation | Glade of the mixed light-coniferous and small-leaved forests |
| **Lake Baraus** | | | |
| Site 11 | 55°8'32.26" N, 60°19'19.82" E | Open water area without submerged vegetation | Glade of the mixed light-coniferous and small-leaved forests |
| Site 12 | 55°8'35.19" N, 60°20'19.76" E | Littoral overgrown with reed | Glade of the mixed light-coniferous f and small-leaved forests |
| Site 13 | 55°8'46.74" N, 60°20'28.32" E | Open water area with submerged vegetation | Edge of small-leaved forests |
| Site 14 | 55°8'52.48" N, 60°19'31.87" E | Littoral overgrown with reed | Birch-aspen forest |
| Site 15 | 55°8'41.13" N, 60°18'40.91" E | Open water area with submerged vegetation | Glade of light-coniferous forest |
| **Lake Large Miassovo** | | | |
| Site 16 | 55°7'29.98" N, 60°16'25.25" E | Open water area with submerged vegetation | Birch-aspen forest |
| Site 17 | 55°7'51.63" N, 60°16'40.43" E | Littoral overgrown with reed | Moist meadow |
| Site 18 | 55°8'12.03" N, 60°17'14.39" E | Littoral overgrown with reed | Moist meadow |
| Site 19 | 55°8'51.30" N, 60°17'10.14" E | Open water area without submerged vegetation | Glade of light-coniferous forest |
| Site 20 | 55°10'21.39" N, 60°17'40.62" E | Non-perennial bog | Moist meadow |
| Site 21 | 55°9'40.91" N, 60°15'47.26" E | Bay with submerged vegetation | Bushes |
| Site 22 | 55°8'38.37" N, 60°15'41.44" E | Bay without submerged vegetation | Moist meadow |
| Site 23 | 55°7'6.58" N, 60°15'26.38" E | Swamp | Bushes |
| **Lake Small Miassovo** | | | |
| Site 24 | 55°9'12.66" N, 60°20'18.41" E | Swamp | Moist meadow |
| Site 25 | 55°9'11.43" N, 60°22'23.27" E | Swamp | Moist meadow |
| Site 26 | 55°9'5.44" N, 60°24'6.00" E | Open water area without submerged vegetation | Steppe-meadow |
| Site 27 | 55°10'53.10" N, 60°20'28.55" E | Open water area without submerged vegetation | Steppe-meadow |
| Site 28 | 55°10'28.26" N, 60°19'7.61" E | Open water area with submerged vegetation | Steppe-meadow |
| Site 29 | 55°9'55.27" N, 60°18'29.99" E | Littoral overgrown with reed | Glade of the mixed light-coniferous and small-leaved forests |

**Table 2.** Species of dragonflies registered for the studied lakes in South Ural lakes, Russia

| Species | Lakes | | | | |
|---|---|---|---|---|---|
| | Baraus | Large Miassovo | Small Miassovo | Ilmenskoe | Savelkul |
| *Aeshna crenata* (Hagen, 1856) | - | + | - | - | - |
| *Aeshna grandis* (Linnaeus, 1758) | + | + | + | + | - |
| *Aeshna juncea* (Linnaeus, 1758) | + | + | - | + | - |
| *Aeshna serrata* (Hagen, 1856) | - | + | - | - | - |
| *Aeshna viridis* (Eversmann, 1836) | - | + | - | + | - |
| *Anax parthenope* (Selys, 1839) | - | + | - | - | - |
| *Coenagrion armatum* (Charpentier, 1840) | - | + | + | + | - |
| *Coenagrion hastulatum* (Charpentier, 1825) | + | + | + | + | + |
| *Coenagrion lunulatum* (Charpentier, 1840) | + | + | + | + | + |
| *Coenagrion puella* (Linnaeus, 1758) | - | + | + | - | - |
| *Coenagrion pulchellum* (Vander Linden, 1825) | - | + | + | + | - |
| *Cordulia aenea* (Linnaeus, 1758) | - | + | + | + | - |
| *Enallagma cyathigerum* (Charpentier, 1840) | - | + | + | + | - |
| *Epitheca bimaculata* (Charpentier, 1825) | - | + | - | + | - |
| *Erythromma najas* (Hansemann, 1823) | - | + | + | + | - |
| *Ischnura elegans* (Vander Linden, 1820 | - | + | + | + | + |
| *Leucorrhinia albifrons* (Burmeister, 1839) | - | + | - | - | - |
| *Leucorrhinia caudalis* (Charpentier, 1840) | - | + | - | - | - |
| *Leucorrhinia dubia* (Vander Linden,1825) | - | - | - | + | - |
| *Leucorrhinia pectoralis* (Charpentier, 1825 | - | - | + | + | - |
| *Leucorrhinia rubicunda* (Linnaeus, 1758) | + | + | + | + | + |
| *Lestes dryas* (Kirby, 1890) | - | - | - | + | - |
| *Lestes macrostigma* (Everssmann, 1836) | + | + | - | - | - |
| *Lestes sponsa* (Hansemann, 1823) | + | + | + | + | + |
| *Libellula depressa* (Linnaeus, 1758) | - | - | - | + | - |
| *Libellula quadrimaculata* (Linnaeus, 1758) | - | + | + | + | - |
| *Macromia amphigena* (Selys, 1871) | - | + | - | - | - |
| *Orthetrum cancellatum* (Linnaeus, 1758 | - | + | - | - | - |
| *Sympecma fusca* (Vander Linden, 1820) | - | - | - | + | - |
| *Sympecma paedisca* (Brauer, 1877) | - | + | + | + | - |
| *Sympetrum danae* (Sulzer, 1776) | - | - | + | + | + |
| *Sympetrum flaveolum* (Linnaeus, 1758) | + | + | + | + | + |
| *Sympetrum pedemontanum* (Mueller, 1766) | - | - | - | + | - |
| *Sympetrum sanguineum* (Mueller, 1764) | - | + | - | - | - |
| *Sympetrum vulgatum* (Linnaeus, 1758 | + | + | + | + | + |
| *Somatochlora metallica* (Vander Linden,1825) | - | + | - | + | - |

Note: +: the species distribution

It can be assumed that the landscape diversity is particularly important for dragonflies. It creates different habitats for different species. We have not found a direct correlation between the trophicity of lakes and the richness of species. A comparison of the species composition using the Jaccard index (Figure 3) has shown that the species composition of individual dragonfly suborders in different lakes also varies depending on the landscape. Lakes with a low diversity of landscapes Savelkul and Baraus (sites 5 and 1) were united in one cluster (see Figure 3). Lakes Large and Small Miassovo (sites 2 and 3) and Ilmenskoe (site 4) characterized by a higher landscape diversity were united into another cluster.

As a conclusion, 36 species (12 Zygoptera and 22 Anisoptera) of Odonata (Insecta) belonging to 15 genera were recorded in the South Urals region lakes such as Lake Large Miassovo, Lake Small Miassovo, Lake Ilmenskoe, Lake Savelkul and Lake Baraus. The trophicity of lakes did not influence the richness of dragonfly' species. The dragonflies' richness was greater for lakes with higher landscape diversity and more types of vegetation.

## ACKNOWLEDGEMENTS

The work was supported by Act 211 Government of the Russian Federation, contract No. 02.A03.21.0011.

## REFERENCES


Balzan MV. 2012. Associations of dragonflies (Odonata) to habitat variables within the Maltese Islands: A spatiotemporal approach. J Insect Sci 12: 87.

Buczyński P, Szlauer-ŁUkaszewska A, Tończyk G, Buczyńska E. 2017. Groynes: A factor modifying the occurrence of dragonfly larvae (Odonata) on a large lowland river. Mar Freshw Res 68 (9): 1653-1663.

Bonifait S, Villard M-A. 2010. Efficiency of buffer zones around ponds to conserve odonates and songbirds in mined peat bogs. Ecography 33 (5): 913-920.

Elo M, Penttinen J, Kotiaho JS. 2015. The effect of peatland drainage and restoration on Odonata species richness and richness. BMC Ecology 15 (1): 11. DOI: 10.1186/s12898-015-0042-z.

Kadoya T, Suda S-I, Nishihiro J, Washitani I. 2008. Procedure for predicting the trajectory of species recovery based on the nested species pool information: Dragonflies in a Wetland restoration site as a case study. Restor Ecol 16 (3): 397-406.

Kent M, Coker P. 1992. Vegetation Description and Analysis. A Practical Approach. Belhaven Press, London.

Krupnova TG, Kostryukova AM, Mashkova IV, Artemyev NE. 2014. Study on hydrobiology and physicochemical parameters of lake Ilmenskoe, Ilmen reserve, Russia. International Multidisciplinary Scientific GeoConference Survey Geol Mining Ecol Manag 1 (3): 671-678.

Krupnova TG, Mashkova IV, Kostryukova AM, Artemyev NE. 2017. The distribution and accumulation of chemical elements in the ecosystem of lake Ilmenskoe. Intl J Geomate 12 (34): 82-88.

Kutcher TE, Bried JT. 2014. Adult Odonata conservatism as an indicator of freshwater wetland condition. Ecol Indicat 38: 31-39.

Mabry C, Dettman C. 2010. Odonata richness and abundance in relation to vegetation structure in restored and native wetlands of the prairie pothole region, USA. Ecol Restor 28 (4): 475-484.

Magoba RN, Samways MJ. 2010. Recovery of benthic macroinvertebrate and adult dragonfly assemblages in response to large-scale removal of riparian invasive alien trees. J Insect Conserv 14 (6): 627-636.

Mamaev BM, Medvedev LN, Pravdin FN. 1976. The determinant of insects of the European part of the USSR. Prosveshchenie, Moscow.

Maynou X, Martín R, Aranda D. 2017. The role of small secondary biotopes in a highly fragmented landscape as habitat and connectivity providers for dragonflies (Insecta: Odonata). J Insect Conserv 21 (3): 517-530.

Nasirian H, Irvine KN. 2017. Odonata larvae as a bioindicator of metal contamination in aquatic environments: application to ecologically important wetlands in Iran. Environ Monit Assess 189 (9): 436.

Nowakowski AB. 2004. Possibilities and principles of operation of the software module "Graphs". Automation of Scientific Research 7.

Popova ON, Haritonov AY. 2008. Interannual changes in the fauna of dragonflies and damselflies (Insecta, Odonata) in the Southern Urals. Russian J Ecol 39 (6): 405-413.

Pryke JS, Samways MJ, De Saedeleer K. 2015. An ecological network is as good as a major protected area for conserving dragonflies. Biol Conserv 191: 537-545.

Rouquette JR, Thompson DJ. 2007. Patterns of movement and dispersal in an endangered damselfly and the consequences for its management. J Appl Ecol 44 (3):692-701.

Rempel RS. 2008. Patch analyst 4-history. http://flash.lakeheadu.ca/~rrempel/patch/whats_new.html.

Simaika JP, Samways MJ. 2011. Comparative assessment of indices of freshwater habitat conditions using different invertebrate taxon sets. Ecol Indicat 11 (2): 370-378.

Snitko LV, Snitko VP. 2013. Phytoplankton of deep-water lakes of Southern Ural (Russia) in high-level water. Intl J Algae 15 (1): 26-35.