Proceedings of the International Conference for the 20th anniversary of China- Mongolia- Russia Daurian International Protected Area

June 25-27, 2014

Dornod aimag Dashbalbar soum
Chukh Eco-tour Herder Community

2014

June 2014
Wildlife Conservation Society (WCS) Mongolia Program Office
#201 San Business Centre, Amar Street-29,
Small Ring Road, 14200, Sukhbaatar District, 8th Khoroo,
Ulaanbaatar 14200, Mongolia

Suggested Citation:
Buuveibaatar, B., Smith, J. K., Edwards, A. and Ochirkhuyag, L. (Eds), 2014. *Proceedings of the International Conference of China-Mongolia-Russia Daurian International Protected Area*. Wildlife Conservation Society Mongolia, Ulaanbaatar.

Cover Photos: WCS Mongolia, S.Bolortstetseg, B.Buuveibaatar, Kirk Olson, Thomas Mueller

Cover Design: L.Ochirkhuyag, J.Khaliuntsetseg (Bit Press Printing House)

Contact information of Editors:

Buuveibaatar Bayarbaatar
Lead for Conservation Science
Wildlife Conservation Society
Ulaanbaatar, Mongolia
Email: buuveibaatar@wcs.org

Justine Smith
Research and Communication Officer
Wildlife Conservation Society
Ulaanbaatar, Mongolia
Email: justineksmith@gmail.com

Ann Edwards
Country Director
Wildlife Conservation Society
Ulaanbaatar, Mongolia
Email: aedwards@wcs.org

Ochirkhuyag Lkhamjav
Remote Sensing/GIS Specialist
Wildlife Conservation Society
Ulaanbaatar, Mongolia
Email: olkhamjav@wcs.org

This volume was produced for the 20th Anniversary of China-Mongolia-Russia Daurian International Protected Area International Conference by the Wildlife Conservation Society Mongolia, with funding from United States Agency for International Development (USAID).

This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the terms of USAID/Global Conservation Partners Cooperative Agreement No. LAG-A-00-99-00047-00. The contents are the responsibility of the Wildlife Conservation Society and do not necessarily reflect the views of USAID or the United States Government.

Printed in Bit Press Printing House.

Contents

Foreword

The Daurian Steppe covers a vast area within the Eurasian steppe region and stretches across the three countries of Mongolia, Russia, and China. These endless steppes are filled with pictur¬esque mountains and hills, and dotted with shallow lakes and wetland areas. This unique ecosystem provides key habitat for millions of migratory birds and is home to splendid mammals including the Mongolian gazelle, Siberian marmot, gray wolf, and many other species.

This year is the 20th Anniversary of the Chinese-Mongolian-Russian Dauria International Protected Area (DIPA). As a part of the anniversary the Wildlife Conservation Society has organized the International Conference on the Dauria International Protected Areas to bring together leading academic scientists, researchers and scholars to celebrate the 20th anniversary, and to exchange and share experiences and research findings that have been conducted across the DIPA.

It our hope that this conference proceedings will provide an update on the status of our knowledge of wildlife research and conservation activities across the Daurian Landscape, in Mongolia, Russia and China. We would like to acknowledge the generosity of USAID who has provided financial support so that this conference could be held, and proceedings produced. Finally, we would like to thank the presenters for their willingness to share their latest research and ideas. Without your efforts, this conference and proceedings would not be possible.

Wildlife Conservation Society (WCS) Mongolia Program

International Cooperation of the Daursky Nature Reserve

O.A. Goroshko[1,2], V.E. Kirilyuk[1], T.E. Tkachuk[1,3], O.K. Kirilyuk[1,2], E.A. Simonov[1]

[1] *Daursky State Nature Biosphere Reserve, Nizhny Tsasuchey, Zabaikalsky krai, Russia*
[2] *Chita Institute of Nature Resources, Ecology and Cryology, Chita, Russia*
[3] *Transbaikal State University, Chita, Russia*
oleggoroshko@mail.ru

Abstract: The level of International Cooperation relating to the management of the *Daursky* State Nature Biosphere Reserve, Russia, throughout its existence (1987-2013) has been considered. The range and types of international activity at the *Daursky* reserve are determined by the reserve's location at the state border and by the fact that it is part of the international protected area, and also by its global importance for global biodiversity conservation. International cooperation is conducted in several ways: through scientific research, environmental education of the local people, participation in the work of international environmental protection organizations, working groups and conventions. The most fruitful and close international cooperation is carried out by the *Daursky* Reserve within the *Dauria* International Russian-Mongolian-Chinese Protected Area. In 1994–2013, with participation of the specialists of the *Daursky* Reserve, 105 expeditions were conducted including 11 trilateral expeditions, with the total duration of more than 1,500 days and the length of automobile routes more than 160,000 km.

Keywords: *Dauria, DIPA, Daursky State Nature Biosphere Reserve, international cooperation*

Introduction

The *Daursky S*tate Nature Reserve was founded on December 25, 1987. It is located in Ononsky and Borzinsky districts of Zabaikalsky krai, Russia, at the border with Mongolia, and near the border with China. It comprises the Russian-Mongolian Tari lakes (the largest water body in East Transbaikalia), steppe sites, the rocky massif Aduunchuluun. Under management of the reserve there are two protected areas of federal significance: the *Tsasucheisky Bor* and the *Dzeren Valley*. The reserve is part of two global ecological regions, which are of key importance for global biodiversity conservation; the regions were identified by the WWF within their Global-200 program, highlighting their importance. They cover the northern and central parts of the ecoregion 'Daurian steppe' (№ 96) and the western part of 'Wetlands of the Russian Far East' (№ 181). In total on the planet 238 such ecoregions are identified. Dauria is of great importance for wildlife conservation, in particular, more than 95% of the global population of Mongolian gazelle (*Procapra gutturosa)* are found in this area. However, the Dauria is especially important for the conservation of birds. The area we consider in this paper is characterized by a large number of globally endangered bird species (23 species), and for the conservation of many of these the reserve is of key importance. This includes the Relict gull (*Larus relictus*) for which only four nest sites for this species' are known in the world, white-naped crane (*Grus vipio*), hooded crane (*G. Monacha*), great bustard (*Otis tarda*), swan goose (*Anser cygnoides*) and many other species. In the area of the Tari Lake, there is a narrowing of the intercontinental arm of the global East Asian-Australasian flyways and there are key stop-over sites for millions of migrating birds. This is also the largest concentration in Asia of migrating cranes, and it is one of several places in the world where six of 15 species of cranes known world-wide can be found simultaneously. The *Daursky* Reserve is part of the transboundary Daurian ecoregion; it forms a united natural complex with the adjacent areas of Mongolia and China. All parts of the Dauria are closely bound to each other, between them there is constant circulation and redistribution of animal populations (depending on the season, multi-year climatic changes and other circumstances).

The *Daursky* Reserve conducts a wide range of international activities, the range and directions of these activities are determined, by the reserve's location at the border of Russia and Mongolia, that it is a part of the international protected area, and by its global importance for global biodiversity conservation. Under conditions of constant re-distribution of the animal population (first of all, birds), protection of a separate part of the natural complex is ineffective, because death of birds in any part of the region leads to an overall population reduction across the whole region. Under these conditions conservation of the unique biodiversity in Dauria is impossible without close international cooperation. The global significance of the reserve's area for biodiversity conservation was the ground for giving it a number of international environmental protection statuses in accordance with international conventions and programs in the sphere of environmental protection. In 1994 the *Daursky* Reserve became part of the only Asia trilateral protected area - the Russian-Mongolian-Chinese *Dauria* International Protected Area (DIPA). The latter comprises the following state nature reserves: the *Daursky* (Russia), the *Mongol Daguur* (Mongolia), and the *Dalai Lake* (China). In the same year, 1994, the Tari Lake obtained the status of wetlands of international importance according to the Ramsar convention, and in 1997 the reserve became a part of the network of UNESCO biosphere reserves. In addition, it is inscribed on two lists of international ornithological areas: Important Bird Areas (BirdLife International program), and as a key area of the global East Asian-Australasian birds' flyway (within the Partnership of this flyway).

International cooperation at the *Daursky* Reserve

International cooperation at the *Daursky* Reserve is conducted in several ways: through scientific research, environmental education of the local people, participation in the work of international environmental protection organizations, working groups and conventions. The first line is developed most intensely in the form of international expedition work (Figure 1). The first international expedition of the *Daursky* Reserve was organized 2 years after its foundation, in March 1990. A specialist from the Central Scientific Research Laboratory in the State Hunting Board, V.Yu. Ilyashenko, and the first director of the Reserve, M.I. Golovushkin, went to north-east Mongolia with the aim of organizing a reserve there on the areas adjacent to the Russian *Daursky* Reserve, and using these areas as the basis for an International Reserve in future. In the course of the expedition the near-border areas were observed, areas for protection were selected, the necessary documents were prepared and the work was conducted on their coordination with the aimag authorities and the government of Mongolia. The next joint expedition in Mongolia with participation of the *Daursky* Reserve was in May-June 1993 under the periods of the Society of Russian-Mongolian friendship. From the Reserve, V.E. Kiriliuk, O.A. Goroshko, A.A. Cherepitsin participated in the expedition, from the Chita State Pedagogical Institute – L.I. Ogorodnikova, from Mongolia – the inspector of nature protection Yunden. The expedition was devoted to studying birds and animals in the lower part of the Ulz river basin including Lake Khukh-Nuur. In the middle of June 1993 in the same area a similar expedition was held on the problems of hydrobiology and hydrology with participation of V.A. Obyazov (the *Daursky* reserve), T.A. Strizhova, I.E. Mikheyev, Yu.V. Lesnikov (Chita Institute of Natural Resources, Siberian Branch of Russian Academy of Sciences) and Yunden.

With the establishment of the *Dauria* International Protected Area in 1994, a period of very intensive Russian-Mongolian cooperation started, which has been going on up to now (Goroshko, 2006; Kiriliuk, 2003; Kiriliuk & Goroshko, 1998; Kiriliuket. al., 2009). Every year in Mongolia 2-7 joint expeditions are conducted in the *Daursky* and the *Mongol Daguur* Reserves; more often they are aimed at studying birds and animals (first of all – rare species). The leading participants of the expeditions are teriologist V.E. Kiriliuk and ornithologist O.A. Goroshko. From Mongolia the key participant until 2001 was zoologist N. Tseveenmyadag; since he left the Reserve many specialists of the *Mongol Daguur* have taken part in the expeditions (Delgermaa, Odmaa, Batdorj, Ulziitumur and others), and during 1999-2001 B. Lkhagvasuren, a researcher from the Institute of Biology (Academy of Sciences, Mongolia), has participated. Some expeditions undertaken by V.E. Kiriliuk, studying the Mongolian gazelle in Mongolia were undertaken together with researchers from the USA – one of the renowned zoologists G. Schaller (1999-2000) and K. Olson (1999-2002), who represented the international organization the Wildlife Conservation Society (WCS). In the course of that work breeding of Mongolian gazelles was researched and for the first time their migration were studied with the help of radio transmitters. A number of Russian-Mongolian expeditions studying and monitoring vegetation were conducted in north-east Mongolia (key participants from *Daursky* reserve: botanists T.E. Tkachuk, L.I. Sarayeva, and N.M. Pazdnikova). Insects have also been studied with participants from *Daursky* Reserve, entomologist G.A. Akulova. At different stages of the work the following specialists of *Daursky* Reserve took part in the joint field works too: ornithologists E.E. Tkachenko, zoologist A.A. Cherepitsin, teriologist Yu.A. Bazhenov, specialists on conservation of nature O.K. Kiriliuk and E.A. Simonov. In recent years, ornithologists of *Daursky* Reserve (S.B. Balzhimayeva) have taken an active role in monitoring birds in north-east Mongolia. Since the beginnings of 2000s a number of expeditions in Mongolia have been trilateral, with participants including ornithologist Liu Songtao, botanist Wuliji and some other specialists from the Chinese *Dalai Lake* Reserve. In 1997, 2005 and 2007 in the research on genetics and ecology of Mongolian gazelle in Mongolia were undertaken, together with the specialists of the *Daursky* Reserve, and researchers from the Institute of Ecology and Evolution (Lushchekina, Kiriliuk, Neronov, 2005).

In total between 1993 and 2013, on the territory of Eastern Mongolia, 95 bilateral and trilateral expeditions were carried on with the participation of the *Daursky* Reserve. The total duration of joint works amounted to about 1,520 days, and the length of the routes — about 175 000 km. In particular, in 2010-2013 ten joint expeditions were carried out for the formation and development of the transboundary network of ecological monitoring in north-east Mongolia with the purpose to find out about environmental changes occurring in the area. Extensive material was collected on flora and fauna, and has been published in 10 joint scientific articles and numerous publications by Russian and Mongolian specialists (Badle et al., 2005; Goroshko, Tseveenmyadag, 2000, 2001, 2003*a*-*c*; Goroshko et al., 2002; Kiriliuk, 1996, 1997, 1999; Kiriliuk, Tseveenmyadag, 1999; Kiriliuk et al., 2012; Tseveenmyadag, Goroshko, 2001; Simonov et al., 2007; and others).

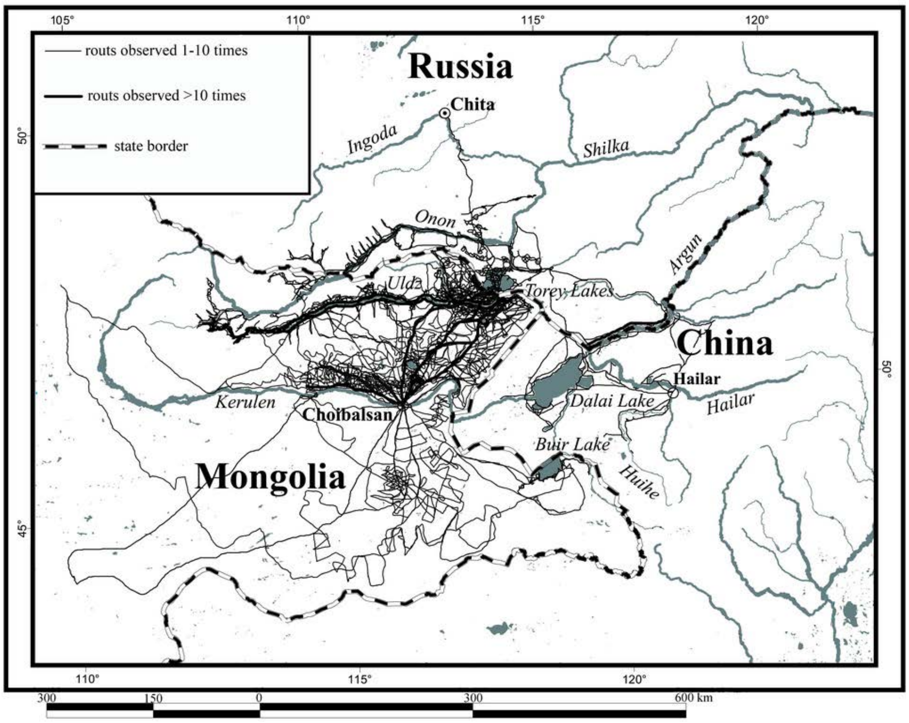


Figure 1. Routes of international scientific research expeditions of the *Daursky* reserve

On the territory of China the first joint expedition of the *Daursky* reserve was held in February-March 1993 on Lake Poyang. It is the largest fresh water lake in China with an area of 3,583 km² located in the subtropical zone, in the south-east of the country in the lower reaches of the Yangtze River. There the most important wintering sites of the globally endangered white-naped crane and Siberian crane (*Grus leucogeranus*) are situated; the expedition was devoted to studying these birds. From the Russian side O.A. Goroshko participated, from the Chinese side - researcher Zhao Jin-Sheng and two more specialists of the *Poyang Lake* Nature Reserve. During the expedition many hours of observation of the cranes' biology were conducted, and spacious muddy shallow waters in the north-western part of the lake were examined in detail on foot. There among the flocks of hundreds of White-naped Cranes we managed to find for the first time 5 birds marked in South-East Transbaikalia with color plastic rings. In addition, a 7-day expedition was carried on to research the northern shore of the lake with the use of a large wooden motor boat. About 200 km of the shoreline were investigated; there we managed to find two important wintering sites of Siberian Cranes previously unknown to scientists. In summer 1993 in the *Daursky* Reserve together with the specialists of the *Poyang Lake* Reserve a joint study on the nesting sites of White-naped Cranes was carried out, and a five year agreement for cooperative research into the protection of the species was signed. The second expedition to study cranes and their winter biology on Lake Poyang was in January 1994. In that expedition, besides the specialists of the *Daursky* and the *Poyang Lake* Reserves, three famous ornithologists from Yakutia Institute of Biological Problems of Cryolithozone (Siberian Branch of RAS) participated: Yu.V. Labutin, A.G. Degtyaryov, N.I. Germogenov, and J. Harris, from the International Crane Foundation (USA). The total duration of the joint work was 45 days. The results of the research were published in a joint scientific article (Harris et al., 1995).

A new stage of the Russian-Chinese cooperation started in 2002 under the banner of the *Dauria* International Protected Area. Totally in the period till 2013 on the territory of north-east China eight joint automobile expeditions of the *Daursky* and the *Dalai Lake* Reserves have been completed, in some of these specialists from the *Mongol Daguur Protected Area* participated. Five expeditions were devoted to studying and monitoring rare species of cranes, geese and other birds, two concentrated on studying vegetation, and one complex expedition to deteremine the transboundary network for ecological monitoring. The work was done in the *Dalai Lake* and *Huaihe* Reserves, and also in the adjacent areas in the basin of the Hailar-Argun to the foothills of the Great Hyangan. There were also five simultaneous expeditions conducted to census and monitor birds at the border River Argun. The Russian and Chinese groups went simultaneously along the border river on both banks conducting censuses used identical methods. The total duration of the joint field works amounted to about 100 days, the length of the routes about 8,400 km. The main participant from the *Dalai Lake* Reserve was ornithologist Liu Songtao, botanic research was carried out by Wuliji. Other participants included Peng Zi-Tian, Bao Ler, Gerilechaoketu and Dou Huashan. From the *Daursky* Reserve the main participant was ornithologist O.A. Goroshko, with additional participation from ornithologist S.B. Balzhimayeva, botanists T.E. Tkachuk and N.M Pazdnikova, as well as some specialists from other scientific research organizations in Russia. New important data were collected on the number and distribution of swan geese, red-crowned (*Grus japonensis*) and white-naped cranes, and on the unique biodiversity of the Argun. These results were published in six joint scientific papers and a number of articles by Russian and Chinese specialists (Goroshko, Liu Songtao, 2003*a, b*; Goroshko, Liu Songtao, Bao Ler, 2004; Simonov et al., 2007 and others).

In July 1992 with participation of the *Daursky* Reserve the first Russian-Japanese field research was held on the territory of Transbaikalia including a study of migration and population estimation of white-naped cranes. That year the first seven birds were marked with transmitters for satellite tracking were attached. Cooperation with Japanese ornithologists in this direction continued in 1993, 1995, 2002 and 2005. As a result, for the first time the migration routes from Dauria to the wintering sites of a number of rare birds: White-naped, hooded and red-crowned cranes, Demoiselle cranes (*Anthropoides virgo*), swan geese, and whooper swans (*Cygnus cygnus*) were identified. In Transbaikalia a series of air censuses of cranes were conducted in the hollow of the Torey Lakes, in Aginsk Steppe, in the vast area of the Onon River basin and in the valley of the Urulunguy (a tributary of the Argun). This enabled the collection of important data on the distribution and abundance of these birds. From Japan the key participant was a member of the Society of Wild Birds and then staff of the University of Tokyo, H. Higuchi. In the work also participated specialists of the same organizations M. Ueta and G. Fujita, and ornithologist of the Yamasina Institute K. Ozaki. From the Russian side, from the *Daursky* Reserve, in all the works participated O.A. Goroshko; at different stages also participated M.I. Golovushkin and V.E. Kiriliuk (the *Daursky* reserve), V.G. Krever (Central Scientific Research Laboratory), and N.D. Poyarkov (Moscow State University), who also played a great part in organizing the work. The results are published in five joint scientific articles (Fujita et al., 2000; Higuchi et al., 1994, 2004 and others).

In 2000 and 2001, with a joint grant from the Russian Fund of Fundamental Research and the Chinese Fund of Fundamental Research, a study on the state of the Mongolian gazelle population in the periphery of the area was carried out by V.E. Kiriliuk, A.A. Lushchekina and Professor of the Peking University Zhigang Jiang (Lushchekina et al., 2000). In September 2001 in Transbaikalia the Russian-American expedition work was conducted to determine cranes numbers at fall pre-migration concentrations in Torey hollow, and also to study their biology and the problem of crop damage by birds. The participants were O.A. Goroshko, specialist of the *Minidoka* National Nature Reserve, S. Bouffard and specialist of the Fish and Wild Service of the USA, J. Cornely. The results are published in two joint articles (Bouffard, Cornely, Goroshko, 2005; Goroshko, Cornely, Bouffard, 2008). In June 2010 a Russian-Japanese expedition was conducted to study and census cranes and other waterfowl and near-water birds in South-East Transbaikalia with participation of O.A. Goroshko, S.B. Balzhimayeva, and the representative of the Japanese organization on conservation of the Red-crowned Crane (Tancho Protection Group) ornithologist Kunikazu Momose.

Collaborative research and monitoring within the Dauria International Protected Area The most fruitful and close international cooperation is carried out by the *Daursky* Reserve within the *Dauria* International Protected Area. From 1994–2013 with participation from the specialists of the *Daursky* Reserve, 105 expeditions were conducted including 11 trilateral ones, with the total duration of more than 1500 days and the length of automobile routes more than 160 000 km. The investigations and environmental protection works covered an area of about 300 000 km^2, from the upper reaches of the Onon River in Mongolia to the Great Hingan mountain range in China. In the beginning of the research the emphasis was on inventory of ground vertebrates; including species composition, distribution, and abundance, as well as location of the most important habitats. Later on special attention was paid to studying globally endangered and vulnerable species of animals, for whom the international protected area is of key importance. This included swan goose, white-naped crane, red-crowned crane, hooded crane, great bustard, relict gull, Mongolian gazelle, Pallas' cat, Siberian marmot, and others. Their distribution and abundance within the spacious Daurian eco-region were determined, main threats were identified, and recommendations were made for conservation and restoration.

A traditionally important line of zoological work is monitoring of populations of birds and animals, particularly, rare and vulnerable species, as well as migrating species. In recent years a similar line of monitoring vegetation has been actively developed. Since 2000, *Daursky* Reserve paid considerable attention to studying the influence of multi-year climatic cycles on Dauria ecosystems. Since 2008, this study is a priority program of DIPA. Within this climate research program, the "Impact of climate change on ecosystems of Daurian ecoregion and ecosystem-based adaptations to them" and a Dauria transboundary network of ecological monitoring (DTNEM) are being conducted and formed. The DTNEM is a widespread Russian-Mongolian-Chinese net of special monitoring transects and plots for multi-year tracking of changes in the ecosystems in the transboundary Daurian ecoregion. DTNEM is a unique type of international cooperation unparalleled in North-East Asia. Prior to the formation of DTNEM, there has been a long period of research into aspects of the International Reserve that started in 1994. Since 2004 periodic censuses of animals aimed at monitoring transboundary ecosystems of Dauria have been carried on. The results of this work have shown a drastic decrease in the abundance of most of the globally endangered bird species in the Dauria, decreases in the numbers of waterfowl, and a number of other extremely dangerous trends. Dauria, besides its global significance for the planet's biodiversity conservation, has two more important features: an extremely high level of ecosystem variability, and a high level of vulnerability of the biodiversity. Every 15 years ecosystems of Dauria change radically due to alternation of multi-year dry and wet climatic periods (total duration of the climatic cycles is about 30 years). For instance, more than 90% of the lakes and rivers in the region can dry out and fill again during these 30 year cycles. Dry periods are critical for survival of many species. Understanding of the processes going on in nature is extremely important for ensuring effective environmental protection and management activities. The areas bordering the protected area are experiencing rapid social and economic development, which leads to equally fast degradation of ecosystems. With this, the negative impacts of human activity exacerbate the unfavorable climatic conditions. All this motivated the staff of the International Protected Area to determine the foundation of DTNEM, and study the influence of climatic changes on ecosystems as a priority collaborative activity. The final aim of this multi-year joint Climate project and DTNEM is to predict the ecosystem level changes that might occur and to determine proposals for their long-term preservation. This includes recommendations for, and rational behind, the sustainable use of natural resources in light of predicted changes for each country and in the transboundary region as a whole.

We are now aware of the key principles of climate cycles in the region and have connected them to the spatial and temporal changes in biota. The main factors and adaptations that help species to survive during critical multi-year periods have also been identified.

Monitoring results will guide the development of specific adaptation measures such as:

- New protected area planning and region-wide spatial planning to secure refuges and corridors for species migrations;
- Development of permissible exposure limits to establish environmental flow requirements for watercourses under the changing climate conditions;
- Better planning of land-use and water consumption;
- Development of other climate adaptation measures, increasing resilience of traditional activities of local communities.

Besides, DTNEM enables to connect to the system of international birds monitoring within the global East Asian-Australasian flyway (in particular, to carry out monitoring of the state of bird populations migrating through the intra-continental branch of this flyway and to elaborate recommendations for their conservation).

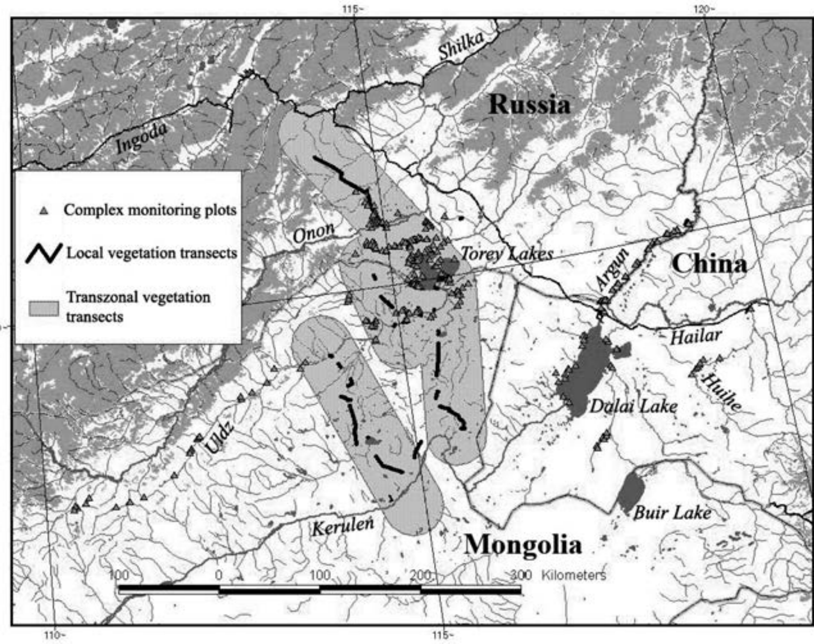


Figure 2. Scheme map of location of complex botanic ornithological plots and geobotanical transects in Dauria transboundary network of ecological monitoring

Active formation of DTNEM began in 2010. The network is functioning already, and the work on its development continues. At present, the following monitoring is being carried out: 1) general state of water bodies; 2) birds populations; 3) vegetation. It is planned to enlarge the objects of research and the parameters. Now DTNEM includes more than 200 complex botanic-ornithological plots for studying the state of wetland ecosystems, as well as geobotanic profiles and plots united into three trans-zonal transects for studying the steppe and forest-steppe vegetation (Figure 2). The network comprises lakes and their hollows, as well as parts of the rivers, river floodplains, steppes, forests. All the plots and profiles are divided into four levels aaccording to frequency of observations: I — observation is not less than once a year; II — once in 2-3 years; III — once in 4-6 years; IV – auxiliary plots. On the lakes in every observation the size of the water surface is studied, the pattern of the shoreline, the state of the reeds and other hydrophyte vegetation, conditions and degree of anthropogenic load, a full census of all waterfowl and near-water birds is carried out, the shore vegetation is described on one or several geobotanic transects laid from the boundary of steppe to the water edge or the center of the hollow (when the lake is dried out completely), and also satellite photos and on-ground photos are analyzed. On geobotanic transects vegetation is described on a 10 m wide strip. In DTNEM all basic varieties and types of lakes, rivers and steppes of the region are represented, that makes the network representative and enables to extend the obtained data to the entire Daurian ecoregion. The work on foundation and maintaining DTNEM includes annual joint expeditions by the research staff of the international protected area in order to choose plots and to describe them regularly, formation of an extensive computer database, analysis of the data, publication and dissemination of the results. For the establishment and development of DTNEM, 15 trips were made to the three countries in 2010-2012.

To implement the Climate program and DTNEM, a new research station, the International Biological Station, has been created on the Torey Lakes in the *Daursky* Reserve at the Utochi cordon, with support of the Russian Government and “Steppe Project” of UNDP/GEF/MNR Russia.

Planned inventory work on vegetation in Mongolia and China is being done. Joint work is being conducted on expanding the network of specially protected areas in Mongolia and on the Russian-Chinese River Argun. Thus, with the participation of specialists from the *Daursky*, *Sokhondinsky* and *Mongol Daguur* Reserves, the *Onon-Baldzh* National Park was founded in Mongolia. Since 2004 in China the specialists from the *Daursky* and the *Dalai Lake* Reserves have undertaken a number of joint studies and monitoring projects on the rare species of cranes and geese in the *Huaihe* National Reserve located at the namesake tributary of the Hailar River. Based on this data, and with participation from DIPA, an action plan was developed on conservation of the great bustard in Asia (Chan, Goroshko, 1998); the information on the state of populations of cranes and great bustards is regularly sent to the IUCN Commission on globally endangered species survival. With the results of research 15 joint scientific papers are published in the English, Russian, Mongolian and Chinese languages, more than 20 joint reports were made at international conferences, forums, symposiums.

Environmental Education

International cooperation of the *Daursky* Reserve in the field of environmental education of local people (first of all, children) has been carried on within the DIPA since 1996. Russian- Mongolian-Chinese contests and exhibitions of children’s paintings are regularly organized. In recent years the co-organizers of the contest have been the regional children’s and youth library and the *Sokhondinsky* Reserve. In 2011, 1,884 artistic works were received from 24 districts of Zabaikalsky krai, Mongolia and China. For the winners joint children’s ecological camps are organized in the *Daursky* Reserve, sometimes - in Mongolia. Twice the camps occurred simultaneously in the *Daursky* and the *Sokhondinsky* Reserves. With the results of the contests the international protected area published 3 albums with the best paintings (2 in Russia, 1 in China). In 2011-2013 thanks to the cooperation of the *Daursky* Reserve and the Japanese organization for conservation of Red-crowned Crane - Tancho Protection Group three international students’ practices were held, when a group of Russian University students with a specialist of the reserve and a teacher of the Zabaikalsky State Humanitarian Pedagogical University (ZSHPU) went to Japan three times to conduct winter censuses and to study the biology of the Red-crowned Crane on Hokkaido, and a group of Japanese students took part in the summer practice of the students of the ZSHPU in the *Daursky* Reserve.

Transboundary Conventions, Working Groups and Meetings

An important aspect of cooperation for DIPA is planning the joint activity, without it the coordinated work of the three protected areas is impossible. The supreme official coordinating body is the Joint Commission, its members are, among others, representatives of the national environmental protection ministries. Meetings of the Commission have been held five times (in 1995, 1996, 2000, 2006 and 2010). In the period between the meetings of the Joint Commission the work of the protected area is coordinated by the Working Group. The Working

Group gathers on average once a year. In its work only specialists of the three reserves take part: members of the administrations, researchers and specialists of environmental education. At these meetings reports on jointly fulfilled work are made, yearly plans of joint activities are determined and adopted, methods and terms of work are coordinated, problems with the cooperation and ways of solving these issues are discussed. In 1994-2013, 23 meetings of the Working Group were held. The DIPA is an example of the most active, fruitful and long-term international nature protection cooperation in North-East Asia; it is a key part of realizing inter-governmental programs and agreements in the field of biodiversity conservation.

Since 2007 specialists of the *Daursky* Reserve have been active participants of the working group on issues of specially protected areas and biodiversity conservation of the Sub-Commission on cooperation in the field of environmental protection of the Commission on preparation of regular meetings of government heads of Russia and China. Every year at the meeting of the working group reports are made about results of Russian-Chinese cooperation in the DIPA and plans for its future development are considered. The sixth meeting of this working group was held in Chita city in 2012, with the leading role of the *Daursky* Reserve in its organizing. Specialists of the *Daursky* Reserve take part in the work of the inter-governmental Joint Russian-Mongolian Commission on issues of environmental protection, and also they are members of some other acting international commissions and work groups in the field of environmental protection: IUCN Commission on species survival (SSC IUCN); working groups on cranes, geese and waders of Eurasia; etc. They act as regional and national coordinators of international nature protection projects (including GEF/UNDP project ‘Improvement of the system and management mechanisms of specially protected nature areas in steppe biome of Russia’).

Thanks to the international significance and active international cooperation the reserve plays a prominent role in realization by the Russian Federation of many conventions and other international environmental protection agreements, including the Convention on Biological Diversity (1992), Convention on Wetlands of International Importance, mainly as habitats of waterfowl (Ramsar Convention, 1971), Convention on Protection of World Cultural and Natural Heritage (1972), Russian-Japanese Convention on Protection of Endangered Migrating Birds and their Environment (1973), Convention on Protection and Use of Transboundary Water Courses and International Lakes (1996), UNO Framework Convention on Climate Change (1992), UNESCO Program ‘Man and Biosphere’ (1971) and others.

Work programs link the *Daursky* Reserve also to other specially protected nature areas in China, Mongolia and other countries, to scientific and nature protection organizations all over the world, including International Crane Foundation, Japan Society of Wild Bird Protection, Tokyo University, Group on Protection of Red-crowned Crane, World Wide Fund for Nature, British Whitley Fund, Partnership of East Asian-Australasian flyway, European Economic Commission and others.

In the period of the *Daursky* Reserve functioning its specialists took part in the work of more than 100 international and foreign congresses, conferences, symposiums and meetings including a number of large ones (the 23d International Ornithological Congress in Beijing, 2002; Forum on the Environment of North-East Asian and North Pacific regions in Tokyo, 1995; the 3d World Congress of Biosphere Reserves in Madrid, 2008; the 21st International Congress on Grass Ecosystems in Hokhot, 2008, and many others).

Conclusion

In conclusion, we must mention another initiative which is realized today within activities of DIPA. It is work on the recognition of transboundary Russian-Mongolian Dauria as the world natural heritage site “Landscapes of Dauria”. The work in this area began in 2012. Getting the *Daursky* and *Mongol Daguur* Reserves status of the World Heritage Site will not only give additional guarantees for ecosystems protection, but also will give a new impetus to the sustainable development of this globally valuable area.

Leaders of the national reserves were essential in assisting in the international cooperation of DIPA, and nomination of the world heritage site. Namely the efforts of the following people are recognized: Tseveenmyadag and Dashdorj (*Mongol Daguur* Reserve), Bai Fu-Chun and Bu Tegen (*Dalai Lake* Reserve), V.A Brinikh and A.P. Borodin (*Daursky* Reserve).

International activity of the *Daursky* Reserve is supported by a number of large international organizations and funds: World Wide Fund for Nature (WWF), International Crane Foundation (ICF). Some international expeditions and environmental educational activities were completed with support from the Ecological Fund of Chita oblast, the East Asian-Australasian Flyway Partnership (EAAFP), UNDP/GEF project ‘Improvement of the system and management mechanisms of specially protected nature areas in steppe biome of Russia’, UNDP/GEF project ‘Biological diversity of steppes of East Mongolia’, Fund of Large Herbivorous (FHL), and the Wildlife Conservation Society (WCS).

References

Badley, J., Busuttil, S., Brookhouse, J., Gombobaatar, S. B., Goroshko, O., Rowland, S., Rowlands, A., Thomas, M., Uuganbayar C. (2005). *Important bird areas survey in Eastern Mongolia (A report on three ornithological surveys during May – September 2004)*. Ulan-Baatar: WCS & RSPB.

Bouffard, S.H., Cornely, J.E., Goroshko, O.A. (2005). Crop Depredations by Cranes at *Daursky* State Biosphere Reserve, Siberia. In *F. Chavez-Ramirez, Editor. Proceedings of the Ninth North American Crane Workshop*: 145-149. Seattle: North American Crane Working Group.

Chan, S., Goroshko, O. (1998). *Action plan for conservation of the Great Bustard*. Asia Council, Tokyo: BirdLife International.

Fujita, G., Guan Hong-Liang, Ueta, M., Goroshko, O., Krever, V., Ozaki, K., Mita, N., & Higuchi, H. (2004). Comparing areas of suitable habitats along travelled and possible shortest routes in migration of White-naped Cranes (Grus vipio) in East Asia. *Ibis*, Vol. 146, Issue 3, 461-474.

Goroshko, O. A., Cornely, J. E., and Bouffard, S. H. (2005). Reduction of crop depredations by cranes at *Daursky* State Biosphere Reserve, Siberia. In *Proceedings of the North American Crane Workshop*: 65-70. Vol. 10.

Goroshko, O., Liu Songtao. (2003a). Data about shorebirds in *Dalai Lake* Nature Reserve (North-Eastern China). In *Ground vertebrates of Dauria: collected scientific papers* – Chita: Poisk publishers: 131-133. Issue. 3.

Goroshko, O.A., Liu Songtao. (2003b). Numbers and habitats of Swan Geese and Ruddy Shelducks in *Dalai Lake* Nature Reserve, North-Eastern China. *Casarca*, 9, 372-376. (In Russian).

Goroshko, O., Liu Songtao, Bao Ler. (2004). Census of cranes and geese in *Dalai Lake* and *Huihe* Nature Reserves in 2004, Inner Mongolia, China. *China Crane News*,Vol 8, N 2, P.2-5.

Goroshko, O. A., Tseveenmyadag, N. (2000). New data about Great Bustard *Otis tarda dybowskii* in basin of the Onon river (Russia and Mongolia). In *The bustards in Russia and adjacent countries:* 29-33. Saratov: Saratov State University publishers. (In Russian with English summary).

Goroshko, O., Tseveenmyadag, N. (2001). White-naped Crane in south-eastern Transbaikalia and north-eastern Mongolia. In *Achievements and problems of ornithology of Northern Eurasia at the turn of centuries*. *Proceedings of the International Ornithological Conference "Urgent problems of birds' study and protection in East Europe and Northern Asia", 2001:* 522-529. Kazan: Magarif. (In Russian).

Goroshko, O. A., Tseveenmyadag, N. (2003a). Data on influence of droughts on population of White-naped Crane. In *Ground vertebrates of Dauria: collected scientific articles:* 121-130. Vol. 3. Chita: Poisk. (In Russian with English summary).

Goroshko, O. A., Tseveenmyadag, N. (2003b). Materials on white-naped and common cranes in north-eastern Mongolia. In *Ground vertebrates of Dauria: collected scientific articles*: 103-120. Vol.3. Chita: Poisk. (In Russian with English summary).

Goroshko, O., Tseveenmyadag, N. (2003c). The state of White-naped Cranes population in Mongolia in 1999 and 2000. In *Ornithological research in Siberia and Mongolia*: 92-115. Issue 3. Ulan-Ude: Buryat State University publishing house.

Goroshko, O., Tseveenmyadag, N., Liu Songtao, Li Ming, Bai Yu-Sun. (2002). Red-crowned Cranes in Dauria steppes. *Newsletter of Crane Working Group of Eurasia*, 4-5, 41. (In Russian and English).

Harris, J.Th., Goroshko, O., Labutin, Yu., Degtyarev, A., Germogenov, N., Jingsheng, Z., Nanjing, Z., Higuchi, H. (1995). Results of Chinese-Russian-American investigation of cranes wintering. In *Cranes and storks of the Amur River. The proceedings of the International Workshop:* 57-72. Halvorson C. H., Harris J.Th. and Smirenski S.M. (Eds.). Moscow: Art Literature Publishers.

Higuchi, H., Ozaki, K., Golovushkin, M., Goroshko, O., Krever, V., Minton, J., Ueta, M., Andronov, V., Smirenski, S., Ilyashenko, V., Kanmuri, N., Archibald, G. (1994). The migration routes and important rest-sites of cranes satellite tracked from south-central Russia. In *The future of cranes and wetlands. Proceedings of the International Symposium*: 15-25. Higuchi H. and Minton J. (Eds.). Tokyo: Wild Bird Society of Japan.

Higuchi, H., Pierre, J., Krever, V., Andronov, V., Fujita, G., Ozaki, K., Goroshko, O., Ueta, M., Smirenski, S., Mita, N. (2004). Using a remote technology in conservation: satellite tracking White-naped Cranes in Russia and Asia. *Cons. Biol*, Vol. 18, Issue 1, 136-147.

Kanai, Yu., Minton, J., Nagendran, M., Ueta, M., Bold, A., Goroshko, O., Kovshar, A., Mita, N., Suval, R., Uzawa. K., Krever, V., and Higuchi, H. (2000). Migration of Demoiselle Cranes in Asia based on satellite tracking and fieldwork. *Global Environ. Res*, Vol. 4 (2), 143-153.

Kiriliuk, V.E. (1996). Numbers and distribution of Siberian marmot (Marmota sibirica) in the lower reaches of the Uldza river (North-East Mongolia). In *Procedings of the 2nd International Meeting on* *marmots of the CIS (Cheboksary, Chuvash republic, Russia, September 9-13, 1996)*: 49-51. Moscow: ABF. (In Russian).

Kiriliuk, V.E. (1997). Mongolian gazelle of the lower reaches of the Uldza river (North-East Mongolia). In *Rare mammal species of Russia and adjacent areas. Proceedings of the international meeting, April 9-11, 1997,* Moscow: 47. Moscow. (In Russian).

Kiriliuk, V.E. (1999). On epizooty of Mongolian gazelle (Procapra gutturosa) in North-East Mongolia. In *The 4th congress of teriological society. (Moscow, April 13-16, 1999). Proceedings*: 118. Moscow. (In Russian).

Kiriliuk, V.E. (2003). Problems of foundation and functioning of transboundary protected nature areas in East Transbaikalia. In *Transbaikalia in geopolicy of Russia (Materials of international conference):* 142-143. Ulan-Ude, Publishing House of Buryat scientific centre, SB of RAS. (In Russian).

Kiriliuk, V.E., Goroshko, O.A. (1998). Scientific collaboration in the *Dauria* international protected area. In *Transboundary specially protected nature areas of North Eurasia: theory and pracrtice (scientific practical bulletin):* 16-22. Issue 1. Moscow. (In Russian).

Kiriliuk, O.K., Gororshko, O.A., Kiriliuk, V.E., Lushchekina, A.A. (2009). Three countries — one Dauria. *Ecology and life*, 9 (94): 64-70. (In Russian).

Kiriliuk, O.K., Kiriliuk, V.E., Gororshko, O.A. (2006). *The Dauria international protected area: 10 years of cooperation*. Chita: Express publishers. (In Russian).

Kirilyuk, V.E., Obyazov, V.A., Tkachuk, T.E., Kirilyuk, O.K. (2012). Influence of Climate Change on Vegetation and Wildlife in the Daurian Eco-region. In *Eurasian Steppes. Ecological Problems and Livelihoods in a Changing World*: 397-424. New York London: Springer Dordrecht Heidelberg.

Kiriliuk, V.E., Tseveenmyadag, N. (1999). Space-time structure of Mongolian gazelle populations in the lower reaches of the Uldza river (North-East Mongolia). In *Rare mammal species of Russia and adjacent areas: collected papers:* 154-167. Moscow. (In Russian).

Lushchekina, A.A., Kiriliuk, V.E., Neronov, V.M. (2005). A comparison of the Mongolian gazelle's studies results from the 1980s up to the present. In *Proceedings of the 9 International mammalogical congress*: 97. Sapporo.

Lushchekina, A.A., Zhigang Jiang, Kiriliuk, V.E., Neronov, V.M. (2000). The Mongolian gazelle (Procapra gutturosa) population on a peripheral part of its range and international cooperation. In *Proceedings to Third Sino-Russian Symposium on Animal Diversity and Regional Sustainable Development, September 18-20, 2000*: 55. China. Urumqi.

Simonov, E., Goroshko, O., Luo Zhenhua, Zheng Lijun, Chen Liang. (2007). Wetlands of Argun midflow – to be or not to be? Preliminary overview of development patterns and environmental impacts. In *Nature-protecting cooperation of Chita oblast (Russian Federation) and autonomous district Inner Mongolia (Chinese People's Republic) in transboundary ecological regions: materials of the conference:* 278-286. Chita.

Tseveenmyadag, N., Goroshko, O. (2001). Some results of study of breeding and autumn migration of rare species of cranes in Eastern Mongolia. In *Ecological system of Eastern Mongolia*: 56-63. Ulan Bator. (In Mongolian).

Justification for the Expansion of the Boundary of the Mongol Daguur Strictly Protected Area

B. Oyungerel[1], N. Tseveenmyadag[2], E. Tuguldur[3]

[1] *Institute of Geography, Mongolian Academy of Sciences*
[2] *Institute of Biology, Mongolian Academy of Sciences*
[3] *Mongolia Program, The Nature Conservancy*

Abstract: Formal protection of key environments is important for ongoing conservation of flora, fauna and ecosystems. The Mongol Daguur Strictly Protected Area is recognized both internationally and in Mongolia as an important environment. As a part of a land classification project carried out by The Nature Conservancy in Mongolia, it was determined that the Mongol Daguur Strictly Protected Area should be expanded. This paper outlines the key reasons why this should occur, and how it will assist conservation of the broader Dauria Steppe environment.

Introduction

The conservation of an area of land is a higher form of environmental protection. Twenty years ago the new classification of the Special Protected Area of Mongolia was established and associated legislation was approved. The network of Special Protected Areas has since been set to meet International standards. The Mongol Daguur Strictly Protected Area is now classified as a Special Protected Area, covering 103,016 hectares, and composing of two parts; A and B. In 1994, "Dauria International Protected Area" was founded covering the Daurski Nature Reserve of the Russian Federation, Dalai Lake National Nature Reserve of the Peoples Republic of China and the Mongol Daguur Strictly Protected Area. This has been playing an important role in conserving the steppes, marshy or wetland environment and rare animals and plants within the transboundary Dauria region. In 1997, the Mongol Daguur Strictly Protected Area and some lakes of its surrounding area were listed in the Wetlands of International Importance, under the Ramsar Convention, in 1998 in the North East Asian Cranes Site Network, and in 2006 in the Earth Network, respectively. The Daguur Steppe is also one of the 200 Global Ecoregions announced by the World Wide Fund for Nature. This suggests that the value of this nature reserve is important not only within Mongolia but also within an international conservation context.

In 2013, the Mongol Daguur Strictly Protected Area was registred as a World Heritage site, a significantly important event that shows its valuable ecosystem should be protected not only in Mongolia but internationally.

Although the Mongol Daguur Strictly Protected Area is internationally recognised as a valuable ecosystem and is relatively well studied, survey material has not been compiled, comparative studies have not been completed, and survey results have not been substantiated through actions. This is related to the sustainability and capability of personnel and financing. The protected area does not cover the whole Dauria ecosystem, and therefore it is impossible to protect the entire range of endangered animals, plants, and migration flyways of waterfowls completely.

As part of a major ecosystem classification project, The Nature Conservancy (TNC), undertook work within the Dauria Steppe region to select ecologically important places for protection (Heiner 2011). This was part of a broader aim related to the impacts of mining development in the steppe area, seeking to reduce adverse impacts, increase sustainable management of animals and the environment in relation to traditional nomadic animal husbandry, and use science to underpin sustainable development. This work determined that it is necessary to expand the boundary of the Mongol Daguur Strictly Protected Area. The size of the area proposed for expansion is 580,080 hectares (Oyungerel 2013).

Grounds for expanding the boundary of the Mongol Daguur Strictly Protected Area (Tseveenmyadag and Oyungerel 2013):

1. In terms of the ecosystem, it shall create the right conditions for conserving the valuable environment. The Daguur Steppe is one of few valuable places that have preserved the appearance of pristine nature that represents unique landscapes such as marshy area and forest-steppes. It will enable the protection of the strip zone of Mongol Daguur Strictly Protected Area parts A and B, to which the Daguur steppe is intruded, and marshy environment, biological diversity and their migration sensitive environment located in the limited sensitive condition.
2. It shall increase protection of rare animals and plants and migration paths. The biodiversity of the Daguur Steppe is considered to be richer than other Euro-Asian steppes, given the number and species of birds and mammals in this region is higher. It is the major boundary area of the larger biogeographic region,

and holds the main concentration of biodiversity and bird migration flyways. Also it is related to ecosystem changes depending on frequency of the climate and its natural adaptability. The depression of Tari Lake is a key nesting habitat for waterfowls and shore birds, which also considered as a critical stopover site along East Asian - Australasian migration flyways. There are 6 crane species in the Mongol Daguur region that holds about 20% of the global population of demoiselle cranes (*Anthropoides virgo*), 12% of common cranes (*Grus grus*), and 5% of white-naped cranes (*Grus vipio*). In addition, this region thought to be home to ~13 % of the global population of endangered great bustards (*Otis tarda*). This area is also characterized as one of the key wintering grounds of Mongolian gazelles (*Procapra gutturosa*), as well as accommodates migration routes of Mongolian gazelles. All these evidences justify that the Mongolia Daguur region requires the specific conservation actions.

3. It is important to undertaken major research across this region. The Daguur Steppe is the largest sample area ofthe natural evolution changes and it can be considered that in relation to the climate changes, its flora and fauna is characterized by its ability to adapt to such changes. This region experiences 30 year climate cycles, transferring from a dry climate into a wet landscape of wetland or marshy areas. Its adaptation to periods of wet to arid, or arid to wet climates, suggests that it is of high scientific value and can be considered as a key area where such process of climate adaptation should be observed and monitored.
4. Protection of endemic species will be increased. Its transitional boundary for many natural regions creates the key condition for habitat of many endemic species of flora and fauna. Many unique places such as springs and mineral water, characterize the landscape, and have preserved natural pristine environments rich in rare and endangered flora. To protect many of these areas of natural beauty the protected area needs to be extended, as many are currently outside the boundary of the nature reserve. It is particularly important to protect the water points and many small lakes which provide key habitat for water birds and other species.
5. The “Mongol Daguur” area is a valuable special protected area of Mongolia, and is registered in many International protection networks, such as the North East Asian Cranes Site Network, Wetlands of International Importance of the Ramsar Convention, the Earth International Conservation Network, as key habitat for Asian rare birds, and in 2013 it was registered as a World Heritage site. Of the 859,102 hectares of the Daguur Steppe located within the trans-boundary World Heritage site, 580,080 hectares or 68% of the regions is located within Mongolia. This represents recognition that this area isan internationally significant, and ecologically valuable ecosystem in Mongolia. The expansion of the boundary of the strictly protected area selected as an ecologically important ecosystem shall play an important role in conservation of the unique combination of Daguur steppe and wetlands and its rare flora and fauna.
6. Since 2008, a trans-boundary regional survey has been conducted within the region regularly and a number of national and international organizations have been implementing long-term complex research work on cranes and bustards. Such works are considered to be important not only in Mongolia but in the international arena. Not only rare birds but other biological species are covered in this survey.
7. It will enable continued development and communication of key nature conservation concepts, including developing new conservation activities with the participation of local citizens and local community, improving ecological education of local people and implementing activities to support their livelihoods whilst working with local communities and considering their opinions to help protect land.
8. It shall play crucial roles in implementation of international and national conventions and agreements including the “Rio Declaration”, “Convention on Biological Diversity”, “Convention to Combat Desertification”, “National Programs on Protected Areas of Mongolia”, “National Biodiversity Conservation Action Program”, “National Program to Combat Desertification”, and “Combat East Asia Dust and Sandstorm”, in which Mongolia have signed.
9. As the Daguur Strictly Protected Area - an valuable place registered in the “International Trans-Boundary Protected Area”, “International Wetlands protection Ramsar Convention”, “North East Asian Cranes Site Network” and “Earth International Conservation Network”and in the World Heritage is the most important place included in many international networks, it is required to expand the size of the area and establish the independent conservation administration at Chuluun Khoroot soum, Dornod.

References

Oyungerel, B. 2013. The Report of areas for expanding the “Mongol Daguur” SPA in 2012-2013.

Heiner, M. 2011. Identifying Conservation Priorities in the Face of Future Development: Applying Development by Design in the Grasslands of Mongolia. TNC Mongolia. Ulaanbaatar.

Tseveenmyadag, N. and Oyungerel, B. 2013. Grounds for listing the “Mongol Daguur” SPA in the World Heritage.

Development of an Effective Protected Areas Network in the North-East Daurian Ecoregion

Olga K. Kirilyuk

Daursky State Nature Biosphere Reserve, Nizhny Tsasuchey, Zabaykalsky Kray, and Institute of Nature Resources, Ecology and Cryology of the Russian Academy of Sciences Siberian Branch, Chita, Russia. e-mail: kiriliuko@bk.ru

Abstract: The Daurian ecoregion, which covers parts of Russia, Mongolia, and China, is a unique, globally important ecosystem. Therefore and effective network of protected areas is important for its ongoing conservation and protection. In this paper we discuss some of the ecological basis for the development of a protected areas network in this area. The current level of protection in the North-East part of Daurian ecoregion, and the coverage of key ecosystems and communities, as well as places that have key significance for the conservation of some rare species, is presented. We provide a proposal for continued development in this region of an effective protected area network, including the establishment of transboundary sites, which are an essential to its success.

Key words: *Dauria, protected areas network, DIPA.*

Introduction

Daurian steppes are a vast region situated in the northern part of Inner Asia on the territory of three countries – Russia, Mongolia and China, and was identified as part of WWF "Global 200" initiative. This ecoregion includes different terrestrial ecosystems from forest steppe in the north to the semi desert and desert to south. But some parts are distinguished by unique climatic conditions, relief, vegetation and wildlife. One such area is the North-East part of the Daurian Steppe ecoregion, situated on the eastern junction of the borders between China, Mongolia and Russia in the Dalai nuur-Tari hollow.

This part of the ecoregion is an example of a well-preserved terrestrial ecosystem in Central Asia. It has key significance for global biodiversity conservation, and is positioned along the biggest migration routes of birds (Kirilyuk, Goroshko & Kirilyuk, 2005). Our study, which took place in this area, will refer to this part of the ecoregion as Dauria.

For the protection of the Daurian ecosystem in March 1994 the Chinese-Mongolian-Russian *Dauria* International Protected Area (CMR DIPA for short) was founded on the base of three Reserves: State Nature Biosphere Reserve *Daursky* (Russia), *Mongol Daguur* Strictly Protected Area (Mongolia) and *Dalai Nuur* National Nature Reserve. Creation of the international reserve allowed the organization of diverse long-term research, and the protection of this famous biodiverse hotspot, with its high concentration of fauna. Long-term research is carried out under the framework of DIPA, and provides data to assist in effective improvement of the DIPA network of protected areas. This paper outlines the current level of protection across the Dauria ecosystem, and proposes key areas in which new protected areas, particularly across transboundary regions, should be established.

Materials and Methods

Reports and materials from long-term expeditions and studies of the International Reserve, as well as materials from chronicles of Nature of *Daursky* Nature Reserve, and additional work by the author's, from projects of INREC SB RAS and *Daursky* Reserve served as the main materials for analysis.

For the spatial analysis, we used GIS, and the ArcGIS software. We estimate for every PA the ratio of the area to perimeter (A / P), which allows the evaluation of the sustainability of the protected area to external influences (Schonewald-Cox & Bayless, 1986). In terms of application of this indicator most resistant the PA, close to round shape, where the value of the criterion A/P tends to between 20 and 25 (Sokolov et al. 1997).

Results and Discussion

At present the total size of the protected areas (PAs) in the Dauria is nearly 5740 hectares, or 14.84 % of the total Dauria area (Table 1). As seen in Table 1, the network of protected areas in China is more advanced. But the highest level of protection, limiting use of the natural environment is placed on the protected areas in the Russian part of the region. The efficacy of the network of protected areas largely depends on the state of the surrounding natural systems, remoteness from other protected areas and the configuration of the specific protected areas. However, the criteria values (A/P) for the largest protected areas did not exceed sixteen. Highest values were obtained for the Chinese reserve *Dalai Nuur*, as well as Russian-

Mongolian clusters of DIPA. From the point of view of the relationship between PA (including the state of surrounding natural systems and the degree of anthropogenic load on the territory) the best values were shown for the protected areas of the Tari nuur, including both Mongolian and Russian protected areas with different status.

The analysis of the representation of major types of plant communities in the protected areas was another criterion for the evaluating the effectiveness of the network of protected areas in the region. Based on maps of scale 1: 1000 000 we indicated within the boundaries of the study area 37 basic types of the plant communities, including steppe, forest steppe and wetlands. Seven of these 37 types are not represented in protected areas; and 18 are present only in protected areas of regional and local status, which cannot ensure their effective long-term safety. The rare Amur-Sakhalin formation which is located at the east of the region is among the most endangered community.

We also analyzed the coverage by protected areas of the key habitat of some rare species, such as swan goose, great bustard, white-napped crane and Mongolian gazelle, taking into account their significance in different periods of climatic cycles. The variability of the Dauria ecosystems in response to cyclical climate fluctuations is one of the most important features of the region (Kirilyuk et. al. 2012). The areas important for certain species during the wet period lose their significance in dry periods and vice versa. Therefore, it is necessary to provide effective protection for the safety of all areas which have importance during different periods of climatic cycles.

Table 1: The presence of different protected area categories, across Russia, Mongolia and China, in the north-east part of the Dauria ecoregion.

Russia			**Mongolia**			**China***		
PA Category	**Number**	**Total area, (thousand hectares)**	**PA Category**	**Number**	**Total area (thousand hectares)**	**PA Category**	**Number**	**Total area (thousand hectares)**
State Nature Reserve	1	209.28	Strictly Protected Area	3	984.6	National Nature Reserve	3	1106.93
State National Park	1	Near 20	National Conservation Park*	1	415.75	Provincial Nature Reserve	5	892.712
Natural refuge of federal significance	2	57.9 + 213.8	Nature Reserve	4	818.07	District Nature Reserve	9	816.4
Natural refuge of regional significance	5	147.5 +47.6						
Nature Monument	24	9.05						
Total	33	705.22		8	2218.42		20	2816.04
% of the total Dauria area in the country		7.1			11.9			27.9

** The information about Chinese PA provided by Ma & Simonov, 2007.*

We also analyzed the coverage by protected areas of the key habitat of some rare species, such as Swan Goose, Great Bustard, White-napped Crane and Mongolian Gazelle, taking into account their significance in different periods of climatic cycles. The variability of the Dauria ecosystems in response to cyclical climate fluctuations is one of the most important features of the region (Kirilyuk et. al. 2012). The areas important for certain species during the wet period lose their significance in dry periods and vice versa. Therefore, it is necessary to provide effective protection for the safety of all areas which have importance during different periods of climatic cycles.

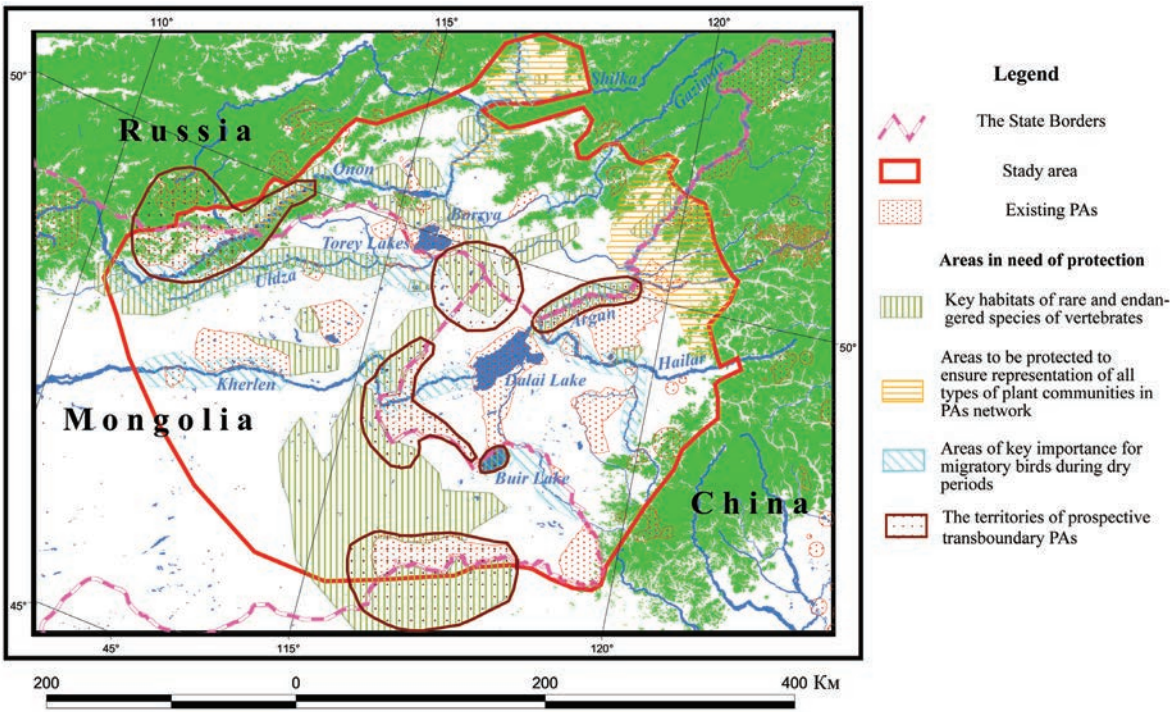


Figure 1: Territories requiring establishment of protected areas in the Dauria Ecoregion (Kirilyuk, 2011).

Studies allowed us to highlight the most important ecological features of the Daurian ecoregion for the building of the Dauria PA network:

- Variability of ecosystems during climatic cycles
- The significance of the region for the conservation of rare and endangered species
- A significant portion of the migratory species in the population of animals in the region

Given all this, we have formulated proposals for the development of a network of protected areas in the region, including transboundary protected areas, as shown in Figure 1.

Some of these proposals have been realized in the Russian part of the Dauria. In 2011 two protected areas were founded: the State Nature Refuge of the federal significance *the valley of Dzeren* to the east from *Daursky* Reserve; and the State Nature Refuge of the regional significance *Semyonovsky* in the north part of ecoregion between the Onon and Shilka Rivers. The *Valley of Dzeren* Refuge was included to DIPA as a territory which is controlled by the administration of *Daursky* Reserve and is closely connected with territories of the Reserve.

Acknowledgements

We express our deep appreciation to all the staff of DIPA, whose research formed the basis for our work.

References

Kirilyuk, O. 2011. *The ecological bases for the foundation of the protected areas network on the north-east part of the Daurian Steppes Ecoregion*. PhD thesis, Institute of water and ecological problems of RAS FEB at Khabarovsk.

Kirilyuk, O., Goroshko, O. & Kirilyuk, V. 2005. *Dauria* International Protected Area: 10 years of cooperation. Chita: Express Publishing House.

Kirilyuk, V, Obyazov, V., Tkachuk, T. & Kirilyuk, O. 2012. Influence of Climate Change on Vegetation and Wildlife in the Daurian Eco-region. In *Eurasian Steppes. Ecological Problems and Livelihoods in a Changing World*: 397-424. New York London: Springer Dordrecht Heidelberg.

Ma, J. & Simonov, A. 2007. PA network of the Argun basin and some prospects for international cooperation in the protection of transboundary ecosystems. In *Environmental cooperation of Chita region (Russian Federation) and the Inner Mongolia Autonomous Region of China (PRC) in transboundary ecological regions.* 221-229. Chita: Zabaykalsky State Humanitarian-Pedagogical University.

Schonewald-Cox, Ch.M. & Bayless, J.W. 1986. The boundary model: a geographical analysis of design and conservation of nature reserves. *Biological Conservaation*, 38: 305-322.

Sokolov, V.E., Filonov, K.P., Nuhimovskaya, Yu.D. & Shadrina, G.D. 1997. Ecology of the Russian Protected Areas. 80-92. Moscow: Yanus.

Wolf Predation on Livestock around the Dalai Lake National Nature Reserve, Inner Mongolia

Dou Huashan[1], Zhang Honghai[2], Wu Muren[1], Gui Manquan[1]

[1] *Dalai Lake National Nature Reserve, Hailaer, 021008*

[2] *College of Life Science, Qufu Normal University, Qufu, 273165*

Abstract: Wolf (*Canis lupus*) predation of livestock is largely responsible for human conflicts, and for the historic collapse of their geographic range. A survey was conducted in Dalai Lake National Nature Reserve in order to evaluate the extent of wolf-livestock conflicts. A pack of wolf, number ranged from three to twelve, was tracked there. From July 2004 to June 2005, a total of 108 livestock were killed by wolves in 41 attacks, and 14 wolves were hunted during the survey the period. Sheep was a major prey of wolves, which comprise of 75% of the total number of livestock killed. For the cattle predation, calves constituted 91.67%, indicating a clear selection by wolves for calves over adult cattle. The similar pattern was observed to horses. The number of livestock killed by wolves was high during September 2004 to March 2005, and wolves were responsible for 91.53% of the total kills observed throughout the year. At least four factors led to this situation: pack size, food supply, photoperiod and influence of humans. Improvements in farm management practices may reduce the wolf-wildlife conflicts. The reintroduction of wild large herbivores to the study area should be advocated as a mean of reducing attacks of wolves on livestock.

Key words: *gray wolf, Canis lupus, predation, livestock, conflict*

Introduction

Wolf-livestock conflict continues to be a major problem associated with wolf conservation efforts throughout the world. Wolves prey on domestic animals everywhere the two coexist (Mech & Boitani, 2003). Historically, the gray wolf was abundant in East Asia, and its range extended all over mainland China (Zhang, Zhang & Wang, 1999). Due to illegal poisoning and other means of killing, wolf (*Canis lupus chanco*) became locally extinct from the majority of their southern range and highly reduced in their northern range in China. Even where wolves were not directly persecuted, they were often vulnerable to incidental declines owing to their large home range and energy requirements and hence small population size. The main conservation problem lies with predation on domestic ungulates, which leads to extensive killing of wolves (Meriggi & Lovari, 1996). In northern and eastern Europe (Pulliainen, 1965; Okaram 1984, 1993; Reig & Jedrzejewski, 1988), as well as North America (Thompson, 1952; Voigt, Kolenosky & Pimlott, 1976; Fritts & Mech, 1981; Fuller, 1989; Huggard, 1993a, b), the wolf feeds chiefly on a few wild herbivore species. Southern European populations have locally adapted to feed mainly on other food resources, e.g. livestock (Fico, Morosetti & Giovannini, 1993), small and medium-sized mammals (Castroviejo et al. 1975), fruit (Meriggi et al. 1991) and rubbish (Macdonald, Boitani & Barrasso, 1980; Reig, Cuesta & Palacios, 1985). However, in east Inner Mongolia, the wolf feeds chiefly on livestock (Gao, 1996). At least two factors work against finding a solution to the problem of predation by wolf on domestic animals: the persistence of inappropriate methods of livestock husbandry, and vanishing of wild large herbivores. If the situation continues this way it will result in a decrease in wolf numbers and an increase in population fragmentation. In Europe and North America, wolf-livestock conflicts have been investigated extensively (Oakleaf, 2003; Bjorge & Gouson, 1985; Fritts, 1982; Fritts et al. 1992; Mech, Fritts & Paul, 1988; Meriggi,1996), but the investigative reporting is absence in China. The aims of our study were (i) to evaluate the extent of wolf-livestock conflicts; (ii) to help devise management guidelines for the conservation of this species.

Study area

The Dalai Lake National Nature Reserve (48°33′N, 117°30′E) is located in northeastern Inner Mongolia, at an elevation of about 550 m above sea level. Our 40,000 hectares study area was on the western lakeshore of Dalai Lake. The climate of this region is arid with a mean annual precipitation range from 247-319 mm. The mean monthly temperature range is from -27^{0}C in January to 19^{0}C in July. We classified habitat types as meadow prairie, steppe, halophytic vegetation, swamp vegetation, sand dune, bare lakeshore and settlement mainly depending on the dominating vegetation species. Hares (*Lepus capensis*), ground squirrels (*Citellus dauricus*), gray wolves (*Canis lupus*), red foxes (*Vulpes vulpes*), corsac foxes (*Vulpes corsac*) are present in the study area. Siberian marmots (*Marmota sibirica*) and Mongolian gazelles (*Procapra gutturosa*), once an important food resource for wolves, have been extirpated. Livestock composed a major portion of wolf prey, and the wolf-livestock conflict became a serious problem as a result. About 50 households reside with livestock farming and fishing in the study area.

Methods

In the winter months, wolves were tracked during periods of snow by cross-country jeep, motorcycle, and on foot. Track was detected easily in snow, prey carcasses and feces present in the territory were collected. In the months without snow, wolf pack size was observed directly at the den, rendezvous, and resting sites. Prey carcasses and feces present in the study area were also collected. The largest number of wolves in the group seen or identified from snow tracking in the territory was accepted as the size of the wolf pack in a given month. Twenty-four livestock farms were surveyed monthly in order to collected data of livestock husbandry and predation on livestock in the study area. Date of sites and tracks were noted by GPS in field, analysis was using SPSS10.0. Excel (2003) was used to create figures.

Results and Discussions

Livestock production in the study area

The Inner Mongolia is a major livestock production area compared with other states of China. Cattle, horses, sheep, goats, and camel constituted the domestic prey available to wolves in the study area. Twenty-four livestock farms with approximately 5,811 livestock are dispersed across the study area. Among livestock species, sheep, goats, and cattle are the most common (Table 1).

Table 1. Composition of livestock in the study area in Dalai Lake National Nature Reserve, Inner Mongolia, China during winter.

Species	Sheep	Goats	Cattle	Horses	Camel	Total
Number	4787	452	495	50	27	5811

Horses and camel are allowed to graze freely, always as far as ten kilometer from settlements. Herders check their number one to three times each month. Cattle are near farm buildings after sunrise, and were herded into the byre before sunset, but herders left them unmonitored during the daytime. Sheep and goats are managed carefully, the herders stays with the flock through the day and the sheep are kept in a barn pen be used at night.

Figure 1. Changes in number of wolves in the pack (unit: individual) during July 2004 - June 2005 near the Dalai Lake National Nature Reserve, Inner Mongolia

Pack size and territory

Wolves generally are widely distributed. The pack, which is tracked in this study, maintained a territory of about 30,000 hectares and the pack size range from three to twelve (Figure 1). Part of a frozen lake was used by wolves in winter. Most of the den, rendezvous, and resting sites were locate in 370 hectares reed marshes without water. The size of wolf pack reached its peak of twelve wolves from July 2004 to September 2004, and the population suffered a continuous decline during winter due to illegal hunting. At the end of March, only three individuals remained in the pack after two wolves dispersed from the study area. Thanks to the birth of eight pups, the population recovered to eleven in April, but six pups were killed by human. All wolf deaths were related to human hunting, which shows the severity of wolf-human conflict.

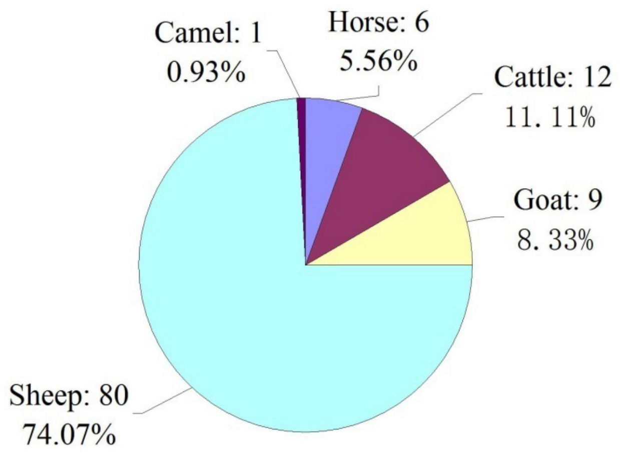


Figure 2. Prey selection of wolf

Predations of livestock by wolves

From July 2004 to June 2005, 108 head of livestock were killed by wolves in 41 attacks. The total economic losses estimated at 53,100 RMB**,** accounted for 15.62% of total income of farmers in the study area. An average loss across the 24 farms was 2,212.50 RMB (± SD 442.50).

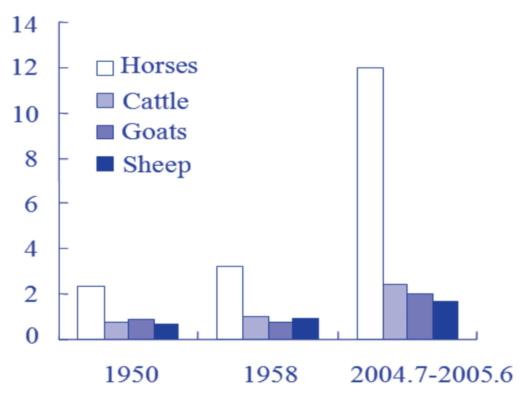


Figure 3. Percent of livestock killed by wolves to total number in the area

Prey selection

Eighty sheep, nine goats, twelve cattle, six horses and one camel were killed by wolves during the study period (Figure 2). Sheep seemed to be the major prey of wolves, which was related to the fact that sheep were the most common livestock in the area. However from another point of view, percent of horses killed compared to the total number of horses was 12%, higher than all other livestock (Figure 3). Lack of care by herders may be the main reason. Horses and camel are left to graze unaccompanied, which provides opportunity for wolves. However only one camel was killed by wolves, possibly due to bigger body and better resistibility. Most cattle killed by wolves were individuals which couldn't be herded back in time. Fritts et al. (1992) indicated that as the grazing season progressed, wolf prey selection patterns seemed to favor younger calves disproportionately; our research supports this observation. Calves constituted 91.67% of cattle lost, indicating a clear selection by wolves for calves over adult cattle, which are more difficult to kill. Despite a lack of the defensive ability, the percent of sheep and goats lost was lower than other livestock. Obviously, protection by shepherd plays an important role in the process.

Dates from Xiqi county (continuous to the study area) records agree with our results. Consequently, the level of wolf predation on livestock shows a remarkably upward trend. The decrease in native wildlife is likely the main reason that led to the recent conflict. For example, Mongolian gazelle, once an important food resource for wolf, has been extirpated in the study area by the late 20th century.

Distribution of depredation

Forty-one attacks were scattered over an area of 30,000 hectares. Predation generally occurred in remote parts of farms, but sites included both distant pastures and sites within a few meters of farm buildings. Wolves prefer swamp vegetation and halophytic vegetation to other habitats when they prey on large-size livestock such as horses, cattle, and camel. About 88.95% of large-size livestock were killed in these habitat types. On one side the ample cover was advantageous for wolves to ambush prey, on the other side it can reduce the chance of detection by herders. Predation on medium-size livestock (sheep and goats) took place near settlement mostly (e.g. 60.67%). Shepherds stay with the flock and give no chance to wolves through the day. But in the night, the situation was completely different: due to power in short supply, there was a lack of night light, so the shepherd can do nothing to defend against attacks by wolves, outside passive actions. There were no livestock grazing in the sand dune and bare lakeshore, as a result, no depredation occurred there.

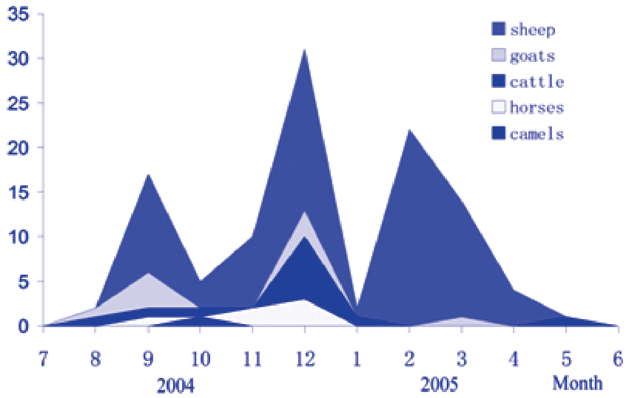


Figure 4. Temporal patterns of depredation on livestock by wolves during July 2004 - June 2005

Temporal patterning of depredation

The amount of livestock killed by wolves was high form from September 2004 to March 2005, about 91.53% of the total number of the year (Figure 4). The situation was directly related to the variety of pack size. Pups were not believed to be predating animals until late fall, when they were capable of killing sheep and goats. However, the food demand of rapidly growing pups, especially in August and September, probably contributed to predation when rendezvous sites were established near farms, so the predation on livestock shows a upward trend since August. There were four wolves dead due to illegal hunting at the end of September, and the number of livestock lost declined markedly. The population of wolf had bottomed out in March, lower level of livestock lost occur during the period.

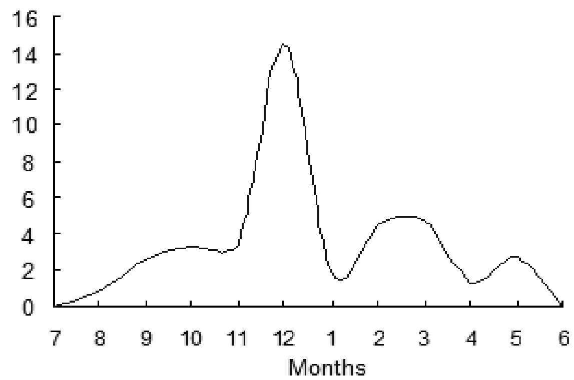


Figure 5. Temporal patterns of predation intensity (1sheep unit/1wolf * 1month) during July 2004 - June 2005. All livestock depredated by wolves were converted into sheep units (1 cattle = 1 horse = 8goats = 8sheep units; 1 camel = 15 sheep units)

We also calculated the predation intensity of wolves in this area (Figure 5), taking into account the reduced movements and appetite: the pups younger than two month were not included. The level of predation intensity was high from September 2004 to March 2005, minimum occurred in June and July. The reasons for the situation were complicated. Firstly, due to starvation and cacotrophia, a great deal of livestock died in April, these carcasses provided food source to wolves without risk, and the predation intensity of wolves declined markedly in the month.

Secondly, as the temperature warmed up since April, most of rodents such as ground squirrels, emerged from hibernation and large quantities of migratory birds reached the area, wolves could live on new food resources instead of livestock. This had been confirmed by our investigation: we found some remnants belonging to birds near the den and rendezvous sites; feather and bone of rodents was present in the feces left by wolves. In June and July, the number of birds and rodent tended to peak, as it happened that there were no livestock lost in this period. Migratory birds began to leave at the end of August, rodents began hibernation from September, and wolves had to shift their target prey to livestock.

Thirdly, in order to avoid human activity, most predation occurred at night (Fritts et al. 1992). In the study area, daytime can reach eighteen hours in summer. Night time is too short to accomplish a kill. The situation was completely different in winter: eighteen-hour night time provided enough time for wolves to prey on livestock with low risk. The pack which we tracked once traveled more than 40 kilometer in December, seven farms were attacked in that night, it was impossible without the cover of darkness. The Dalai Lake begins to thaw in April, many fisherman come to the conservation area, the influence of humans increases remarkably, these may be one of the reasons that predation intensity of wolf declined since April.

High predation intensity in December may be related to the "overkill" behavior of wolves. Seven cattle, three horses, eighteen sheep and three goats were killed in eleven attacks. The amount of livestock killed was beyond the wolves' requirements and many carcasses were left behind, as a result, predation intensity was low in January.

Attitude to wolf

Interviews about the perceptions of wolves by farmers was conducted in twenty-four farms. All farmers agreed that the wolf-livestock conflict was serious; most of them considered the population of wolves to be less than previously. Though all of them know that wolves are protected by law, they also expected wolves to be hunted in order to mitigate the economic loss. Wolves have been regarded as a kind of vermin, and hunting wolves was encouraged by the government historically (Gao, 1986). For example, 603 wolves were killed by the government of Xiqi county in 1948. Ethical tradition also contribute to the present attitude: the local herders have an enmity against wolves, if anyone killed a wolf, sheep will be given as a offering. Some farmers suggested that the government should provide compensation for loss of livestock to wolves, but verifying claims of wolf predations is a problem, as livestock carcasses deteriorate or are sometimes quickly consumed or dragged away, and inclement weather or livestock activity destroys predator signs near kill sites (Fritts et al. 1992).

Management Recommendations

Some suggestions can be used to mitigate the effects of wolves and promote more stable coexistence between wolves and humans.

1) Management practices at many of the farms could be improved: improve surveillance of large-size livestock such as cattle and horses, reduce pasturing in remote areas, and delay turnout until young livestock are more capable of eluding wolves.

2) Strengthen management in winter (from September to March), night light should be used at night. The use of livestock-guarding dogs should be encouraged when feasible.

3) Wolves may be attracted to the presence of livestock carcasses or other discarded animal parts, remove them from the vicinity of a farmyard to remote area.

4) Scarcity of wild ungulates appeared to enhance predation on domestic livestock. The reintroduction of wild large herbivores should be advocated as a means of reducing attacks on livestock.

5) Education are important, the masses' attitude to wolves is the key to a stable coexistence between wolves and humans.

Acknowledgements

Our study was funded by the National Natural Science Foundation with grants 30370218. We wish to thank Zhang You and Tong Jirimutu of Dalai Lake National Nature Reserve for the assisted with fieldwork. We especially thank Prof. Gao Zhongxin of Northeast Forestry University for his helpful comments on this paper.

References

Bjorge, R.R. & Gouson, J.R. 1985. Evaluation of wolf control to reduce cattle predation in Alberta. *Journal of Range Management*. 38: 483-487.

Castroviejo, J., Palacios, F., Garzon, J. & Cursta, L. 1975. Sobre la alimentacion de los canides ibericos. *Proceeding XH Congress International Union Game Biologists*, Lisboa. pp. 39-46.

Fico, R., Morossetti, G. & Giovannini, A. 1993. The impact of predators on livestock in the Abruzzo region of Italy. *Revue Scientifique et Technique, Office International Epizooties*. 12: 39-50.

Fritts, S. H. & Mech, L.D. 1981. Dynamics, movements, and feeding ecology of a newly protested wolf population in northwestern Minnesota. *Wildlife Monographs*, 80: 1-79.

Fuller, T.K. 1989. Population dynamics of wolves in North-Central Minnesota. *Wildlife Monographs*, 105: 1-41.

Fritts, S.H. 1982. Wolf depredation on livestock in Minnesota. *U.S. Fish and Wildlife Service, Resource Publication*. 145.

Fritts, S.H., Paul, W.J., Mech, L.D. & Scott, D.P. 1992. Trends and management of wolf-livestock conflicts in Minnesota. *U.S. Fish and Wildlife Service, Resource Publication*. 181. 27 pp.

Gao, Z.X. 1986. Mammals of Heilongjiang province. *Heilongjiang Province Technological Publication*. 231-241.

Gao, Z.X. 1996. Inner Mongolia Wolf Food habits. *Acta Theriologica Sinica*. 16: 95-99.

Huggard, D.J. 1993a. Prey selectivity of wolves in Banff National Pack. *Canadian Journal of Zoology*, 71: 130-139.

Huggard, D.J. 1993b. Effect of snow depth on predation and scavenging by gray wolves. *Journal of Wildlife Management*, 57: 382-388.

Macdonald, D.W., Boitani, L. & Barrasso, P. 1980. Foxes, wolves and conservation in the Abruzzo Mountain. *Biogeographica*, 18: 223-235.

Mech, L.D. 1970. The wolf: ecological and behavior of an endangered species. *Natural History Press, New York, NY*. 384pp.

Mech, L.D. and Boitani, L. 2003. Wolf social ecology. Page 1-34 in Mech, L.D. and L. Boitani, editors. Wolves: behavior, ecology, and conservation. *University of Chicago Press*. Chicago. Illinois.

Mech, L.D, Fritts, S.H. & Paul, W.J. 1988. Relationship between winter severity and wolf depredation on domestic animals in Minnesota. *Wildlife Society Bulletin*. 16: 269-272.

Meriggi, A. & Lovari, S. 1996. A review of wolf predation in southern Europe: does the wolf prefer wild prey to livestock? *Journal of Applied Ecology*. 33: 1561-1571.

Meriggi, A., Rosa, P., Brangi, A. & Matteucci, C. 1991. Habitat use and diet of the wolf in Northern Italy. *Acta theriologica*, 36: 141-151.

Oakleaf, J.K., Mack, C. & Murray, D.L. 2003. Effects of wolves on livestock calf survival and movements in central Idaho. *Journal of Wildlife Managemen*t, 67: 299-306.

Okaram, H. 1984. The physical condition of red deer falling prey to the wolf and lynx and harvested in the Carpatian Mountains. *Acta theriologica*, 29: 283-290.

Okaram, H. 1993. Status and management of the wolf in Poland. *Biological Conservation*, 66: 153-158.

Pulliainen, E. 1965. Studies on the wolf (*Canis lupus*) in Finland. *Annales Zoologici Fennici*, 2: 215-259.

Reig, S., Cuesta, L. & Palacios, F. 1985. The impact of human activities on the food habits of red fox and wolf in Old Castille, Spain. *Revue d'Ecologie (Terre Vie)*. 40: 151-157.

Reig, S. & Jedrzejewski, W. 1988. Winter and early spring food of some carnivores in Bialowieza National Pack, eastern Poland. *Acta theriologica*, 33: 57-65.

Thompson, D.Q. 1952. Travel, range and food habits of timber wolves in Wisconsin. *Journal of Mammalogy*, 33: 429-442.

Voigt, D., Kolenosky, G.B. & Pimlott, D.H. 1976. Changes in summer food of wolves in Central Ontario. *Journal of Wildlife Management*, 40: 663-668.

Zhang, H.H, Zhang, P.Y. & Wang, Z.L. 1999. Status of the world's wolves. *Journal of Qufu Normal University*, 25: 101-103.

Siberian Marmot (Tarbagan) in the Daurian International Protected Area, Russia

Yu. A. Bazhenov

State Nature Biosphere Reserve "Daursky", and Institute of Natural Resources, Ecology and Cryology, Siberian Branch of the Russian Academy of Sciences, Chita, Russia; e-mail: uran238@ngs.ru

Abstract: In 2013, we studied the distribution and abundance of tarbagan in the Russian part of the Dauria International Protected Area. The estimated number of tarbagan in the Daursky Reserve and its buffer zone was less than 200 individuals. In the Federal Zakaznik "Dolina dzerena" - more than 5,000 individuals. We recommend to protect areas in East Transbaikalia region to expand distribution and increase population size of tarbagan.

Keywords: *tarbagan, Siberian marmot, Marmota sibirica, Transbaikalia, Dauria, population*

Siberian marmot, or tarbagan (*Marmota sibirica* Radde, 1862) from Eastern Transbaikalia (Zabaikalskiy kray, Russia) is listed in the Russian Red Book as an endangered species. However, current number and distribution of tarbagan in the region is poorly studied. In 2013, we conducted a study of the tarbagan population on the Russian side of the Dauria International Protected Area. In order to estimate number of marmots in the study area, we conducted an extensive survey to count all marmot burrows. In addition, we also collected data on marmot distribution and numbers opportunistically along the routes with length of 29 km. At the Daursky Reserve, tarbagan were found at only in a isolated single site. The population of this colony estimated with only 10-20 individuals. However, in the buffer zone of the Daursky Reserve, more than 10 burrows were located. The size of these colonies were varied between 1 and 15 families. It is estimated that the total number of tarbagan in Daursky Reserve and its buffer zone is approximately 150-200 individuals.

The density of tarbagan colonies was the greatest in the Federal Zakaznik called the "Dolina dzerena" region (Figure 1). Whereas, distribution of tarbagan colonies were evenly distributed along the border between Russia and Mongolia. Approximately 550 tarbagan families live in area of 600 ha that locate away from the international border and settlements. However, the core distribution of the animals is concentrated in areas between state border and settlements. This area was the site of conservation of tarbagan during intensive hunting of this species. Several separate settlements are known in other parts of the reserve. We estimated the total number of the tarbagan in the protected areas to be roughly 5000 – 6000 individuals. Further studies need to be implemented to estimate the population size of tarbagan accurately. Tarbagan also actively settle in adjacent territories on Nerchinsky Ridge. Thus, the number of tarbagan in southeastern Transbaikalia exceeds previous estimates of around 1,500 - 2,500 individuals (Kyrylyuk & Puzanskiy, 2012).

The tarbagan in the Daurian steppe plays a key

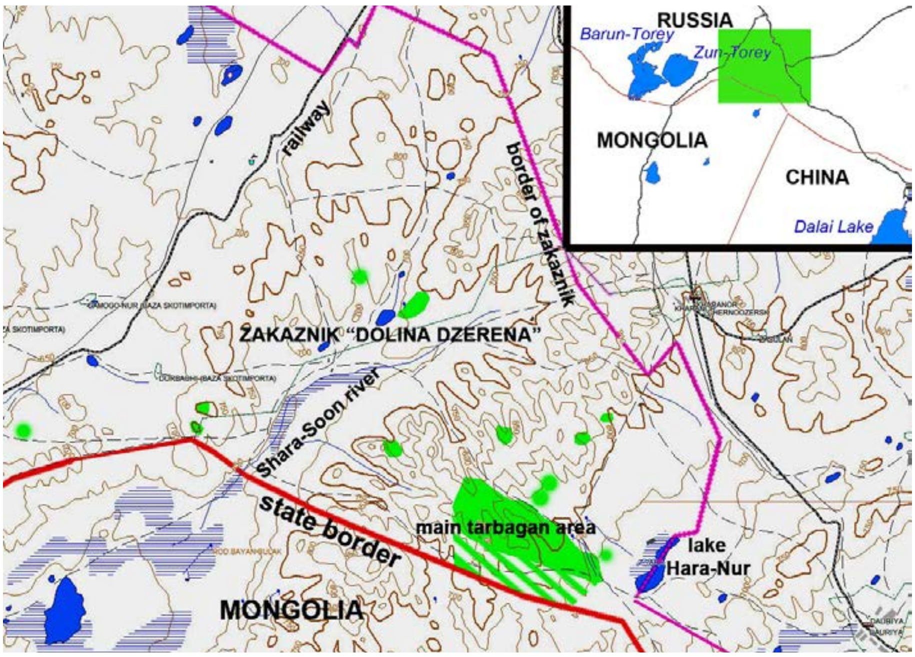


Figure 1. The key settlements of tarbagan in zakaznik «Dolina dzerena».

role in the ecosystem of this region. For instance, tarbagan burrow provides optimal shelter for the Daurian pika (*Ochotona daurica* Pallas, 1776) and Daurian ground squirrel (*Spermophilus dauricus* Brandt, 1844), and many other species. It has shown that the density of Daurian ground squirrels is 5-10 times greater in areas where tarbagan burrows are present (Bibikov, 1949). The habitat of tarbagan in the reserve is crucial for other endangered birds of prey such as steppe eagles (*Aquila rapax* Temminck, 1828) and golden eagles (*Aquila chrysaetos* L., 1758) during the breeding season in summer. From the perspective of management, the creation of a reserve in Mongolia (neighborhood Mountain Shavart), adjacent to the Zakaznik «Dolina dzerena» will be the best option for further development of the trans-boundary reserve, conservation and restoration of tarbagan in Daurian steppe.

References

Bibikov, V.S. 1949. On the ecology of the Daurian ground squirrel. News of Irkutsk Plague Institute of Siberia and Far East. eds (7).

Kyrylyuk, V.E. and Puzanskiy, V.N. 2012. Mongol marmot, or tarbagan. Red book of Zabaikalsky kray: 40-41. Novosibirsk, «Novosibirsky izdatelsky dom».

Monitoring Biodiversity with Camera Trapping in Mongol Daguur Strictly Protected Area, Mongolia

Munkhjargal Myagmar[1], Susan Townsend[2], Gombobaatar Sundev[1], Nathan Conaboy[3]

[1]*Steppe Forward Program and National University of Mongolia, Ulaanbaatar, Mongolia*
[2]*Wildlife Ecology & Consulting, San Francisco, USA*
[3]*Steppe Forward Program and Zoological Society of London, UK*

Abstract: This paper presents species specific occupancy estimates of a study site at Mongol Daguur Strictly Protected Area during 2011 and 2012; as part of a broader study between 2009 and 2012 to assess how effective protected areas were in functioning to conserve biodiversity. We established two camera trap grids in different management zones representing buffer zone and limited zones in Mongol Daguur SPA. Camera trapping effort was similar between 2011 and 2012 during which period two grids were surveyed simultaneously; grid I in the buffer zone and grid II in the SPA proper. During 2011 across both grids there was a high degree of overlap between species type, likely due to similarity of habitat between grids. Marmota had higher occupancy estimates in the SPA than in the buffer zone. Generally, similar occupancy estimates in both grids were noted for carnivores. Mongolian gazelle had higher occupancy in the buffer zone than SPA. In 2012, 4 species were detected in the buffer zone and 5 species were detected within the SPA. There was a very low degree of overlap between species type this year. Roe deer, grey wolf and marmot were detected only within the SPA. Mongolian gazelle also had higher occupancy within the SPA than the buffer zone. The study showed evidence of poaching in the SPA and buffer zone, and livestock was present in low numbers in both grids. Our study found that marmots had a much higher occupancy within the SPA than in the buffer zone each year, despite almost identical habitats. This finding indicates that the SPA appeared to be conserving source populations of this species.

Keywords: *camera trapping, occupancy, biodiversity, Mongol Daguur Strictly Protected Area, Mongolia*

Introduction

With advances in camera trapping methods, it is now possible to monitor trends in the diversity, abundance, and distribution of a broad range of terrestrial mammals and birds in a variety of habitats ranging from savannah to deserts and tropical ecosystems (Ahumada et al. 2011; Burton et al. 2011; O'Connell et al. 2011; Pettorelli et al. 2010). Camera trapping is a particularly attractive approach for monitoring because it is non-obtrusive, has low observer error, is comparable across sites, data can be aggregated for various indices, and photographs allow for verifiability. Setting and maintaining camera traps does not require highly skilled staff and it is lower in cost when compared to other approaches of equal rigor (O'brien, unpublished data).

Landscape level wildlife monitoring with camera traps has generally been implemented in tropical ecosystems [O'brien et al. 2010; Ahumada et al. 2011 (see Tropical Ecosystem Assessment & Monitoring Network; www.teamnetwork.org)], parts of Africa (Petorelli et al. 2010; Burton et al. 2011; Collen et al. 2011) and for certain trophic levels (such as carnivores, see Pettorelli et al. 2010; Burton et al. 2011). Published studies of landscape level camera trapping in temperate regions are rare. Mongolia supports both temperate grassland and forested ecosystems and is part of the Holarctic ecozone.

As this study considers species occurrence and distribution, camera trapping is a logical choice for documenting occupancy over large areas. Occupancy modeling allows for estimating true occupancy and provides detection probabilities. A species may go undetected in a sample unit even if that species is actually present. This "false absence" leads to underestimation of true occupancy. In addition, unless the probability of detection is determined, measures of occupancy over time are invalid (MacKenzie et al. 2005).

As a case study from 2009 to 2012, we assessed how well protected areas were functioning to conserve wildlife (biodiversity) in Mongolia using camera trapping. We hypothesized that biodiversity, presence of medium to large mammal species and species specific occupancy estimates would be higher in the more restricted management zones in the protected areas than in the less restricted management zones. In order to test this, we set up camera trapping grids in two different zones in each study area. We assumed there would be less anthropogenic influence in the more restrictive zone.

The five study areas representing 4 ecoregions that were sampled over 4 years included Myangan Ugalzat National Park located in Tsetseg Soum, Khovd Aimag; Khonin Nuga located in a valley in the western Khentii region; Onon-Balj National Park located in the Eastern Khentii; Mongol Daguur Strictly Protected Area located in northeastern Dornod Aimag; and Numrug Strictly Protected Area located in the farthest east of

Mongolia in Dornod Aimag. In this paper, we present species specific occupancy estimates of a study site at Mongol Daguur Strictly Protected Area (hereafter SPA) in 2011 and 2012.

Materials and Methods

Study area

Mongol Daguur SPA (Part A) and Buffer Zone are located in northeastern Dornod Aimag in the Eastern Steppe of Mongolia (Figure 1). The eco-region is the Mongol Daguur Steppe (based on Tsegmid 1969; Clark et al. 2006). Elevation ranged from ~650 to 1030 m. This area is characterized by classic steppe vegetation and low relief. Small lakes, both fresh and salt, were fairly common. Portions of Mongol Daguur part A are wetlands. The SPA is immediately adjacent to the Russian border and is part of the border zone. We selected two grids in different management zones (buffer zone and pristine/limited zones) in Mongol Daguur SPA (Figure 2).

Camera Trapping

Approximately 100 camera stations were deployed in 2 ~50 sq km grids. We relied on rangers and park officials to show us management zone and park boundaries for grid locations. The first camera station point for each grid was randomly selected. Camera stations were deployed in 1 km apart from each other and uniquely identified by line letter and number (for example, A1, A2, A3, etc.). We used hand-held GPS to determine 1 km spacing.

Each Scoutguard 550 camera station was set up to maximize the likelihood of mammal and bird detections and, when possible, perpendicular to a logical animal pathway (3 - 5 m away) at a set height for a specific target zone. The camera station points were within 100 m of the 1 km coordinate. Camera stations were mounted with a nylon strap at a height to capture wildlife > 1 kg onto a 1.2 m wooden stake in the ground. The height of the camera on each stake was recorded and standardised to capture a target area ~ 3-4 m away; the height varied because of the terrain. The following details were recorded for each camera point; location (GPS coordinates), grid identification, camera station ID, names of team members, SD card and camera serial numbers, date and time of set up, and habitat and elevation. Cameras were set to camera mode, 3 images per event, 5 mp size, 8 second interval between events, high or normal sensitivity level, and time stamp on.

The camera station was tested during set up by having a person walk ~3 to 5 m (target zone for detection) in front of the camera station while in test mode to verify the camera could detect movement in the target area. Settings were checked. We recorded the set up date, camera station identifier, and location on a whiteboard and took a picture of it at each station. Camera stations were maintained for proper functioning. SD cards were collected or downloaded during maintenance if the SD card was full or appeared to be malfunctioning. During maintenance, the number of pictures taken and remaining, settings, battery status, date and time were recorded. During camera station take down we noted the same data as above and verified that the camera station was working properly.

Data from SD cards were downloaded into directories for analysis. The database was arranged to identify location, start and end date, grid, and camera station ID. Digital photographs were batch re-named, georeferenced and catalogued. Species and number of individuals were recorded for each image during cataloguing. Summary of species detected, how often and other data were tabulated from the catalogued images.

Data Analysis

Camera trap days were the number of nights that camera stations were up and functioning. For our analysis, we used the number of events (3 photographs were taken per event) and recorded when a species was detected and the number of individuals (maximum number per event). Empty shots resulted from moving vegetation, missed detections (presumably), loose stake (camera itself moved causing a trigger) and for other unknown reasons. In addition to wildlife, checking events, humans and livestock were also included in the data analysis.

The number of functioning trap-days, number of species and individuals, and trap success (rates of detection) were calculated. An occupancy estimate, ψ, for each species detected for the season was determined using the program PRESENCE (v3.2, Hines, 2006). We used single-season occupancy models to estimate initial occupancy probabilities (ψ) and detection probabilities (ρ) for each species (MacKenzie et al. 2003). Occupancy models account for imperfect detection and provide unbiased estimates of occupancy. To apply these models, detection histories are compiled for each species at each grid (Grid I and Grid II) for each camera station in a series of ones (detection) and zeros (non-detection). Each day the camera was up was considered a (re)survey. Each day the camera station was "down" or not functioning was treated as a missing value.

We modeled each of our grids separately. We ran 2 pre-defined models and used the model with lowest delta AIC to estimate probability of detection and occupancy as calculated by the software PRESENCE (Hines, 2006). The first model estimated the same occupancy probability for all camera station points and that detection probability (ρ) was constant across both camera station point and survey occasions (i.e., two parameters). The second model assumes that all camera station points have the same probability of occupancy (ψ), but that ρ varies between the surveys although at each survey occasion, ρ is the same at each camera station point. PRESENCE uses Akaike's Information Criterion (AIC) to rank models (Burnham & Anderson, 2002), which relies on rules of parsimony. In this case, twice the log-likelihood values at the maximum likelihood estimates were used to calculate the AIC values in model weighting.

Results

Camera trapping effort was similar between 2011 and 2012 (Table 1). All images were catalogued. Events were used for analysis.

Table 1:

Ninety-four camera stations in 2011 and hundred camera stations in 2012 were set in 2 grids; grid I was located in the Buffer Zone and grid II was located in the SPA. Both grids were in steppe habitat. Grid I was set in early June and taken down July 19 and grid II was set up between June 5 and July 20 in 2011 and 2012. The majority of events were empty shots and wildlife events constituted less than 3 percent of the total for both grids for both study years (Table 2).

Table 2:

In 2011, roughly similar proportions of tolai were detected in Grid I and II, respectively (Table 3). Rodentia (almost entirely *Marmota sibirica,* Plate 1) constituted 56% of wildlife events for Grid II and 20% for Grid I (Table 3). Artiodactyla constituted only 1% of events for Grid II, but markedly higher in Grid I at 14% [Table 3, Mongolian gazelle (Plate 2)]. Mesocarnivores including *Mustela* sp. in Grid I and *Vulpes vulpes* in Grid I & II were detected (Plates 3 and 4).

Table 3:

In 2012, rodentia (almost entirely *Marmota sibirica*, Plate 1) constituted 47% of wildlife events for Grid II, but no detection in Grid I. Artiodactyla constituted 10% of events for Grid II, but markedly higher in Grid I at 54% (Table 3). Carnivores were detected 11% in Grid I and 18% in Grid II (Plates 5 and 6).

Occupancy estimates were calculated for all species (or taxonomic groups) that were reliably detected by the camera stations. We estimated occupancy estimates, ψ, and detection probability, ρ, for all species with the software Presence. Several species were detected too infrequently to generate occupancy estimates and, in those cases, we report the observed occupancy.

Mongol Daguur study site had high relative biodiversity and 10 species detected in each grid respectively in 2011. Occupancy estimates were compared between grids; there was a high degree of overlap between species type, likely due to similarity of habitat between grids. *Marmota* had higher occupancy estimates in Grid II than Grid I, and souslik had higher occupancy estimates in Grid I than II. Generally, similar occupancy estimates were noted for carnivores for each grid. Mongolian gazelle had higher occupancy in Grid I than II (Table 4).

Table 4:

In 2012, 4 species were detected in grid I and 5 species were detected in grid II in Mongol Daguur SPA. Occupancy estimates were compared between grids; there was a very low degree of overlap between species type this year. Roe deer, grey wolf and marmot were detected only in Grid II. Mongolian gazelle had higher occupancy in Grid II than Grid I (Table 4).

Discussion and Conclusion

Terrestrial mammals are important components of all Mongolian ecosystems and while some efforts have been put forth to identify their status and distribution (Clark et al. 2006; Batsaikhan et al. 2010), very few if any reliable population estimates are known. Our study was focused on specific protected areas and our findings reflect the status of terrestrial mammals there. We have detected some threatened species in Mongol Daguur SPA in 2011 and 2012 with our camera trapping effort.

Table 5:

Mongol Daguur SPA and its buffer zone represented steppe habitat with little human influence, although we had expected no human influence in an area that close to the Russian Border (border zone) and where livestock is restricted (the SPA, Grid II). In fact, there was evidence of poaching in the SPA, and livestock was present in low numbers in both grids. Interestingly though we found that marmots had a much higher occupancy in Grid II than Grid I each year, despite almost identical habitats. This finding indicates that, in fact, the SPA appeared to be conserving source populations of this keystone mammal. The continued implementation of the camera trapping in Mongol Daguur SPA could enable us to measure biodiversity trends using the Wildlife Picture Index method based on occupancy over time.

Mongol Daguur SPA harbors a rich suite of classic steppe species. The SPA boundaries could be expanded considering the low population density and little or no use of this area by livestock. There is an excellent potential for partnership between SPA rangers, park management and border guards to conserve wildlife. Additionally, the status of transboundary species such as the Mongolian gazelle is unknown and continuing to monitor in the SPA and buffer zone can document the use and status of this and other transboundary species in this region.

Acknowledgements

Funding and support were provided by the

Zoological Society of London and The Netherlands Government through NEMO2 - World Bank. Additional invaluable in country support was provided by the National University of Mongolia, the Mongolia Program, Wildlife Conservation Society, the Mongol Daguur Park Administration and Border Defense Agency. We would like to express thanks to our field biologists.

References

Ahumada, J.A., Silva, C.E.F., Gajapersad, K., Hallam, C., Hurtado, J., Martin, E., McWilliam, A., Mugerwa, B., O'brien, T., Rovero, F., Sheil, D., Spironello, W.R., Winarni, N. and Andaelman, S. J. 2011. *Community structure and diversity of tropical forest mammals: data from a global camera trap network*. *Philosophical Transactions of the Royal Society B*, 366: 2703 – 2711.

Batsaikhan, N., Samiya, R., Shar, S. & King, S.R.B. 2010. *A Field Guide to the Mammals of Mongolia* Zoological Society of London, London.

Burnham, K.P. & Anderson, D.R. 2002. *Model Selection and Multimodal Inference*. 2nd Edition. Springer-Verlag, New York.

Burton, A.C., Sam, M.K., Kpelle, D.G., Balangtaa, C., Buedi, E.B. & Brashares, J.S. 2011. Evaluating persistence and its predictors in a West African carnivore community. *Biological Conservation*. Doi:10.1016?j.biocon.2011.06.014.

Clark, E. L., J. Munkhbat, S. Dulamtseren, J.E.M Baillie, N. Batsaikhan, R. Samiya, & M. Stubbe (compilers and editors). (2006). *Mongolian Red List of Mammals*. Regional Red List Series Vol. 1. Zoological Society of London, London.

Collen, B., Howard, R., Konie, J., Daniel, O. & Rist, J. 2011. Fields surveys for the endangered pygmy hippopotamus *Choeropsis liberiensis* in Sapo National Park. *Oryx,* 45: 35-37.

Hines, J.E. 2006. Presence v3.2 – Software to estimate patch occupancy and related parameters. USGS-PWRC.

MacKenzie, D.I., Nichols, J.D., Hines, J.E., Knutson, M.G. & Franklin, A.D. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. *Ecology*, 84: 2200-2207.

MacKenzie, D.I., Nichols, J.D., Sutton, N., Kawanishi, K. & Bailey, L.L. 2005. Improving inference in population studies of rare species that area detected imperfectly. *Ecology*, 86: 1101-1113.

O'Brien, T.G., Baillie, J.E.M., Krueger L. & Cuke, M. 2010. The Wildlife Picture Index: Monitoring top trophic levels. *Animal Conservation*, 13:335-343.

O'Connell, A.F., Nichols, J.D. & Karanth, K.U. 2011. *Camera traps in Animal Ecology: Methods and Analysis*. Springer, Tokyo.

Pettorelli, N., Lobora, A.L., Msuha, M.J., Foley, C. & Durant, S.M. 2010. Carnivore biodiversity in Tanzania: Revealing the distribution patterns of secretive mammals using camera traps. *Animal Conservation*, 13: 131 – 139.

Tsegmid, Sh. 1969. *Mongolian physical geography*. Publishing House of the Mongolian Academy of Sciences, Ulaanbaatar. (Mongolian)

Table 1: Camera station effort for Mongol Daguur SPA in 2011 and 2012

Year	Trap nights	Photographs	Events
2011	3,164	67,145	22,912
2012	3,198	29,690	9,896
Total	**6,362**	**96,835**	**32,808**

Table 2: Number and proportion of total events for Mongol Daguur SPA, Mongolia 2011 and 2012

Year	Grid	Empty	Check	Wildlife	Livestock	Humans
2011	1	8,999 (0.93)	168 (0.02)	204 (0.02)	128 (0.01)	16 (0.00)
	2	12,403 (0.93)	183 (0.01)	344 (0.03)	175 (0.01)	6 (0.00)
2012	1	3,629 (0.93)	201 (0.05)	28 (0.01)	37 (0.01)	9 (0.00)
	2	5,738 (0.96)	152 (0.03)	89 (0.01)	12 (0.00)	1 (0.00)

Table 3. Number of wildlife events and proportion by taxonomic group (p) for Mongol Daguur SPA, Mongolia 2011 and 2012

Year	**Grid**	**Wildlife**	**Lago**	**p**	**Rod**	**p**	**Artio**	**p**	**Carn**	**p**
2011	1	204	11	0.05	40	0.20	28	0.14	37	0.18
	2	344	10	0.03	192	0.56	5	0.01	42	0.12
2012	1	28	1	0.04	0	0	15	0.54	3	0.11
	2	89	5	0.06	42	0.47	9	0.10	16	0.18

Lago = Lagomorpha, Rod = Rodentia, Artio = Artiodactyla, Carn = Carnivore

Table 4: Occupancy estimates for each grid for Mongol Daguur 2011 and 2012 (ψ = occupancy estimate, SE = standard error)

TAXONOMIC CATEGORY	Species	2011		2012	
		Grid I	***Grid II***	***Grid I***	***Grid II***
		***ψ*(±SE)**	***ψ*(±SE)**	***ψ*(±SE)**	***ψ*(±SE)**
O. Insectivora	*Mesechinus dauuricus*	-	*0.05**	-	-
O. Lagomorpha	*Ochotona* sp.	-	0.0331 (0.04)	-	-
	Lepus tolai	0.2845 (0.15)	0.5902 (0.54)	*0.0217**	-
O. Rodentia	*Marmota sibirica*	0.0241 (0.02)	0.6006 (0.08)	-	0.4692 (0.12)
	Spermophilus sp.	0.2442 (0.09)	*0.09**	-	-
O. Carnivora	*Mustela* sp.	0.0331 (0.05)	-	-	-
	Vulpes vulpes	0.5721 (0.52)	0.4432 (0.22)	*0.0217**	-
	Vulpes corsac	*0.02**	0.0271 (0.03)	-	-
	Canis lupus	0.5816 (0.34)	0.3193 (0.13)	-	0.5455 (0.26)
	Meles meles			*0.0435**	-
O. Artiodactyla	*Procapra gutturosa*	0.6861 (0.27)	0.0343 (0.06)	0.499 (0.31)	0.6349 (0.56)
	Capreolus pygargus	0.0915 (0.05)	*0.05**	-	*0.0227**
	Cervus elaphus	*0.02**	-	-	-
Human Influence	Humans	0.1541 (0.09)	0.1848 (0.17)	0.5171 (0.44)	*0.0227**
	Livestock	1	0.9667 (0.24)	0.2324 (0.2)	0.1172 (0.09)

**observed occupancy*

Table 5: Red list species detected Mongol Daguur SPA

Species	Common name	Red List Status	2011	2012
Cervus elaphus	Red deer	*Critically Endangered*	*D*	-
Marmota sibirica	Siberian marmot	*Endangered*	*D*	*D*
Procapra gutturosa	Mongolian gazelle	*Endangered*	*D*	*D*
Canis lupus	Grey wolf	*Near Threatened*	*D*	*D*
Vulpes vulpes	Red fox	*Near Threatened*	*D*	*D*

(D = detected)

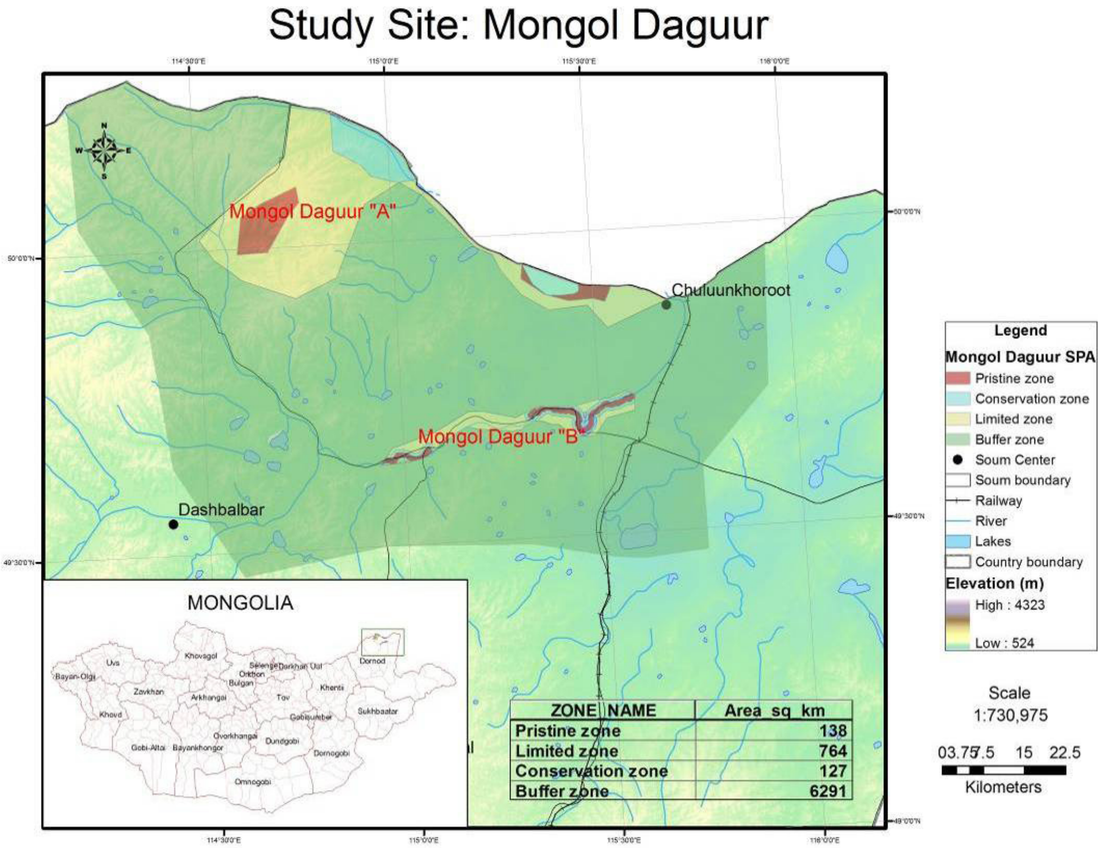


Figure 1: Mongol Daguur SPA, Dornod Aimag, Mongolia

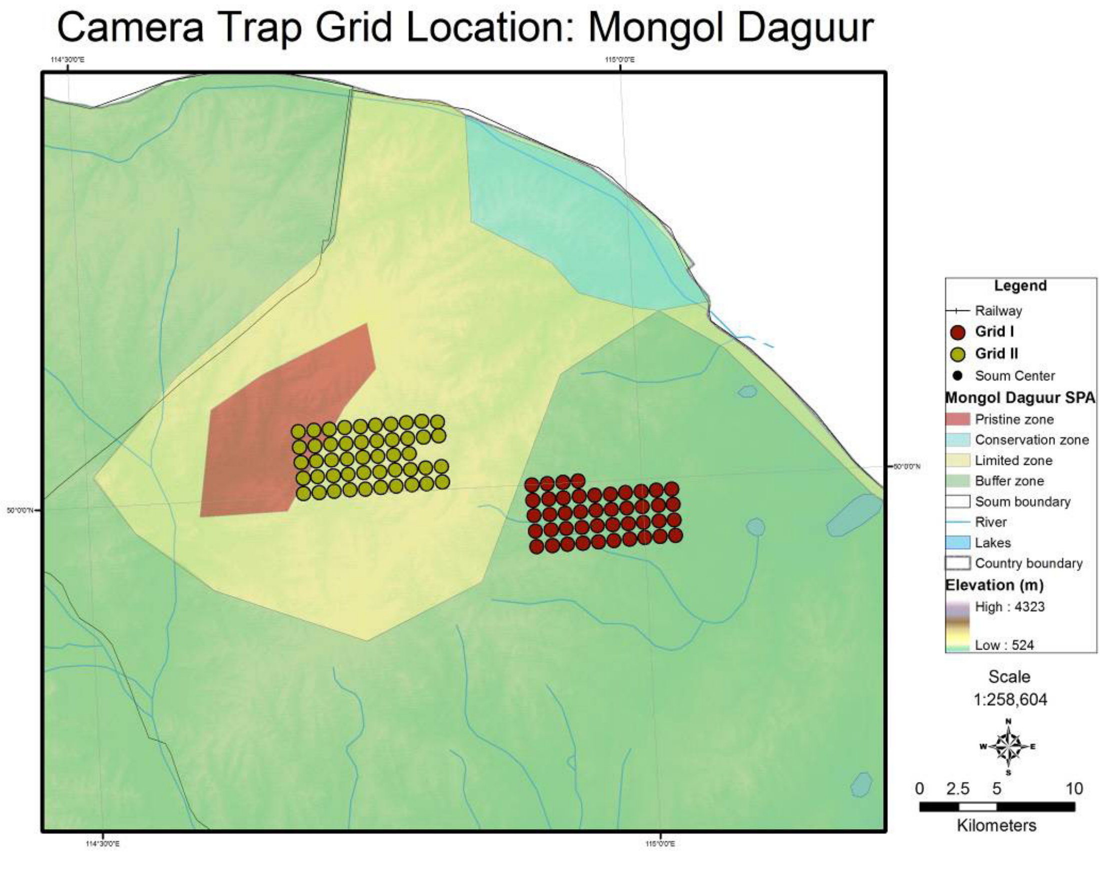


Figure 2: Mongol Daguur SPA camera trap locations (Grid I & II)

Plate 1: The Siberian marmot, *Marmota sibirica*, Grid I, Mongol Daguur SPA

Plate 2: Mongolian gazelle, Grid I, Buffer Zone of Mongol Daguur SPA, Mongolia

Plate 3: *Mustela* sp., Grid I, Mongol Daguur SPA, Mongolia

Plate 4: *Vulpes vulpes*, Grid II, Mongol Daguur SPA, Mongolia

Plate 5: Eurasian badger, Grid I, Buffer Zone of Mongol Daguur SPA, Mongolia

Plate 6: *Canis lupus*, Grid II, Mongol Daguur SPA, Mongolia

Annotated List of Mammals of the Daursky Biosphere Reserve, and the Tsasucheisky Bor and the Valley of Dzeren Refuges

Yu.A. Bazhenov [1,2] , V.E. Kiriliuk [3]

[1]*State Nature Biosphere Reserve "Daursky", Russia, Zabaikalskiy kray, Nizhniy Tsasuchey vil.;*
[2]*Institute of Natural Resources, Ecology and Cryology, Siberian Branch of the Russian Academy of Sciences, Chita, Russia; e-mail: uran238@ngs.ru*
[3]*Daursky State Nature Biosphere Reserve, Nizhny Tsasuchey, Zabaikalsky krai, Russia*

Abstract: The article contains the new annotated list of Mammals of the Daursky Biosphere Reserve and subordinated territories. The data about 54 species of Mammals from 16 families and 6 orders are provides. Previous list of mammals consisted of 47 species. The information about history of research of South-East Transbaikalia are also provided.

Key words: *Mammals, Dauria, South-East Transbaikalia, Daursky Biosphere Reserve*

The first data about mammals of South-East Transbaikalia are in the works of the researchers of the 18-19th centuries I.G. Gmelin, P.S. Pallas, and G.I. Radde. Valuable descriptions of game species were made by A.A. Cherkasov (1867).

In the first half of the last century mammals of the region were studied by B.A. Kuznetsov (1929) and by the head of the nature department in the Chita museum of local history E.I. Pavlov (1935, 1948, 1949, 1966). A considerable contribution was made by professor V.N. Skalon (1935, 1936). Since the 1930s and up to recent time multidimensional research was done by zoologists who worked in the anti-plague service: A.S. Fetisov, N.V. Nekipelov, V.V. Khrustselevsky, V.M. Lipaev, A.N. Leontyev, I.P. Brom, B.I. Peshkov, S.V. Hamaganov and many others. They wrote hundreds of articles about distribution, numbers and various aspects of mammals biology. Near the Torey lakes up to recent time there was a multi-year stationary site of the Chita anti-plague station.

The first list of mammals of the *Daursky* reserve was made by the reserve's first director — M.I. Golovushkin with the materials of his own research, literature data, as well as the data collected by the planning and surveying expedition headed by A.S. Alexandrov. Visiting mammalogists took part in inventory work, in particular — Yu.G. Shvetsov (1990) and students of different institutions of higher education. Since 1990 research of mammals has been conducted by V.E. Kiriliuk (2003), and since 2008 — by Yu.A. Bazhenov (2012). During several years karyotypic examination of some mammals was carried on by V.P. Korablov, M.V. Pavlenko and other specialists of Biological and Soil Institute of the Far-Eastern Branch of the Russian Academy of Sciences. On the whole, the general species composition of the animals of the reserve and its nearest environs is studied relatively fully but distribution of the species over the area (especially of small species) still needs further investigations. Besides, climatic changes and bound to them changes of landscapes affect both the numbers and the chances for the species existence in one or another part of the area.

The reserve has the area of nearly 50 thousand ha. However, taking into consideration a small area of dry land in the *Daursky* reserve and cluster location of its sectors the work covers the territory comprising both the reserve proper and the surrounding buffer zone (about 173 thous. ha), and two refuges (zakazniks) of federal importance subordinated to the administration of the *Daursky* reserve — the *Tsasucheisky bor* (59 thous. ha) and the *Valley of Dzeren* (213 thous. ha). Though the *Tsasucheisky bor* zakaznik is located close to the reserve, it has considerable biotopic differences. The zakaznik included almost entirely the island-like pine forest that mostly burned out in 1998-2003 and 2012 and in fact turned into forest-steppe. A small part of the pine forest (300 ha) to the south of the zakaznik belongs to the reserve (Forest-steppe sector), it was also partly burned in 2012. The rest of the reserve is the water area of Lake Barun-Torey and the adjacent floodplain and steppe sites. Among the steppes predominate low-bunchgrass, herb-grass, leymus and filifolium types in various combinations. A special place holds the Adon-Chelon sector of the reserve. It is characterized by a greatly broken relief with outcrops of rocks. There predominant are true and mountainous petrophyte steppes, in splits and on the northern slopes shrubages are found, birch and aspen groves are common. The *Valley of Dzeren* federal zakaznik was founded only in November, 2011. In the east it adjoins the *Daursky* reserve. Open landscapes of the zakaznik embrace the southern part of the Nerchinsky mountain range represented by a ridge of low mountains. The rest of the territory is characterized by hilly ridge elements of relief alternating with broad intermountain depressions partly occupied with lakes and salines. In the north-western part the reserve is crossed by the floodplain of the Borzya river. Inventorying of the fauna in the *Valley of Dzeren* is just being carried on but the zakaznik's vicinity to the *Daursky* reserve prompts a similar mammal species composition there.

In the reserve, its buffer zone and the *Tsasucheisky bor* and *Valley of Dzeren* zakazniks, and also on their territory before their foundation, since 1930s 54 mammal species have been registered. Until late 19th — early 20th centuries two more species lived or regularly appeared there: argali and khulan. It is not improbable that red wild dog also came there. A later reference about meeting a red wild dog (Kiriliuk, 2003) is flimsy for all that, as numerous messages about the presence of this predator in Zabaikalsky krai have no factual proofs. Since 70s–80s of the 20th century, that is the foundation of the *Tsasucheisky bor* zakaznik and the *Daursky* reserve, on their territory 50 species have been recorded. Since that time the grey-sided vole and the Asian chipmunk have not been noted already, though they were known there in the middle of the previous century (the latter one, though, was noted in 2013 nearby the zakaznik's boundary), the northern bat has not been recorded in the reserve, and in the *Valley of Dzeren* — Manchurian shrew. These 4 species may be found now too with high probability, that is why they are inscribed on the annotated list. By 2006-11 as a result of aridization with the accompanying fires and drying of wet biotopes the Eurasian lynx, the raccoon dog had disappeared from Tsasucheisky pine forest, red deer, wild boar, ermine, long-tailed souslik had stopped coming, squirrel had become few in numbers again. In the reserve in the surroundings of the Torey lakes at the same time raccoon dog, muskrat disappeared, least shrew, steppe and eastern bats, harvest mouse, Siberian weasel were not registered any more, habitats of reed vole remained extremely localized. Of singular finds we should specially note Laxmann's shrew (errors in the species identification are possible) and an accidental (not occasional, as for lynx, red deer and wild boar) coming of a wolverine in the winter 2010/2011 northward of the Torey lakes. The wolverine crossed not only the reserve but most of the *Valley of Dzeren* zakaznik, and nearly reached the settlement of Zabaikalsk. In January 2014 in the reserve's sector Adon-Chelon a lynx was found. Its traces tell that the animal stayed in the site for at least some weeks.

For estimating abundance of the species permanently living on the protected territory a four-point scale was used besides the concrete indexes of the numbers (density). Of predatory, hoofed and hares as very rare are identified the species, which are found not more frequently than once in three years, as rare — those, which are found 1-3 times in two years (less than 0.5 individuals/1,000 ha), as common — found several times in a year (from 0.5 up to 10 indiv./1,000 ha), as numerous — found tens of times in a year (more than 10 indiv./1,000 ha). The other groups of mammals are placed into one or another category of abundance under the following conditions: very rare — the same conditions as in the above case; rare — widely spread but with the population density less than 0.1 indiv./10 ha or in singular, limited in size habitats (less than 10 ha); common — regularly but in small numbers (0.1 to 10 indiv./10 ha) found in most of the biotopes or in larger numbers but in some small (tens of ha) sites; numerous — found in considerable numbers in most of the biotopes (10 to 100 indiv./10 ha) or in some biotopes where they occupy parts considerable in the area (hundreds of ha) in even greater numbers. As an index of abundance (ia) for some small species is a number of animals' entrapments per 100 cylinder-days (c-d) while catching with standard zoological grooves (50 m, 5 cylinders). Classification of mammals is given according to Pavlinov (2006).

Order – EULIPOTYPHLA

Family Erinaceidae

1. Daurian hedgehog – *Hemiechinus dauuricus* Sundevall, 1842

A common species, population density in seasons and in different typical for the species areas is between 0.5 and 4 individuals/10 ha. Inhabits all the dry parts of the reserve, the buffer zone and both of the zakazniks, except wet parts in the river floodplains and the islands of the Torey lakes. Prefers steppe biotopes with sandy and rocky soil and agrocenoses. Common in Tsasucheisky pine forest.

Family Soricidae

2. Laxmann's shrew – *Sorex caecutiens* Laxmann, 1788

The pattern of staying is unknown. Caught only twice: in the buffer zone on a steppe terrace near the Imalka river floodplain in the summer of 1994, and in the reserve in the shallow waters of the Uldza river in December 1996.

3. Large-toothed shrew – Sorex daphaenodon Thomas, 1907

A rare species in droughty years. Registered in the floodplain and near-floodplain parts of the Uldza and Imalka, at the Utochi channel, as well as in Tsasucheisky pine forest.

4. Boreal shrew – *Sorex tundrensis* Merriam, 1900

A common, in some years (in fall time) numerous, species. Found in all parts in the environs of the Torey lakes, keeps to wet biotopes (especially numerous is in the floodplains of the Uldza and Imalka — up to 23-25 animals/100 c-d), very rarely noted in the parts with steppe vegetation. A common species in the shrubby parts of Tsasucheisky pine forest (ia up to 16) and in the birch tree groves of Adon-Chelon.

5. Least shrew – *Sorex minutissimus* Zimmermann, 1780

Common in Tsasucheisky pine forest (ia up to 7) including the Forest-steppe sector of the reserve. The only meeting at the Torey lakes was registered by Mineyev in 1938 between Solovyovsk village and Lake Zun-Torey (Fetisov, Khrustselevsky, 1948).

6. Manchurian shrew – *Crocidura shantungensis* Miller, 1901

Earlier was considered as scilly shrew – *C. suaveolens* Pallas, 1811. One of the two known for Zabaikalsky krai locations of this spieces is in Ikkiri hollow within the boundaries of the *Valley of Dzeren* federal zakaznik (Lamkin, Puzansky, 2000).

Order – CHIROPTERA

Family Vespertilionidae

Bats in the reserve's location live only in summertime from May to August-early September. Winterings are not registered. The numbers of all the species are decreasing in the reserve and the buffer zone due to reduction of shelters — separate constructions.

7. Eastern bat – *Myotis petax* Hollister, 1912

Earlier was considered as water bat – *M. daubentoni* Kuhl, 1817. A very rare species. It was found by G.I. Radde (1862) on the shore of Lake Zun-Torey (Nekipelov, 1961). Reliably noted is one meeting under a house siding in the buffer zone of the reserve at the Imalka floodplain (1995).

8. Steppe bat – *Myotis aurascens* Kuzyakin, 1935

Earlier was considered as whiskered bat – *M. mystacinus* Kuhl, 1817. A common in some years species. Small colonies (up to 15-20 animals) and single individuals inhabit various constructions at water bodies (the Imalka, Lake Barun-Torey) in the reserve and the buffer zone. In recent (droughty) years the species has not been registered.

9. Northern bat – *Eptesicus nilssoni* Keyserling et Blasius, 1839

Modern finds are unknown. The species was noted in the middle of the 20th century on the territory of the present buffer zone of the reserve at Kulusutay village and near the southern boundary of the *Tsasucheisky bor* zakaznik (at Bain-Tsagan village) (Nekipelov, 1961).

10. Long-eared bat – *Plecotus auritus* L., 1758

Rare. Registered in 1934 in Kulusutay village on the present territory of the reserve's buffer zone (Nekipelov, 1961). In late 1980s some individuals were found in constructions at the southern boundary of the *Tsasucheisky bor* zakaznik (Golovushkin M.I., personal information). The only known sector of the reserve where the bat is a common species is Adon-Chelon. There the animals keep to rocky skerries with numerous splits.

11. Serotine bat – *Vespertilio murinus* L., 1758

Numerous. Colonies up to 100-150 animals inhabit many separate constructions, as well as natural shelters in rocks. Registered in all steppe sectors of the reserve and the buffer zone, in the *Valley of Dzeren* zakaznik, and in Tsasucheisky pine forest where it lives in hollows and splits of trees.

12. Eastern bat – *Vespertilio sinensis* Peters, 1880

A common species. Single individuals and small groups up to some tens of animals inhabit some separate constructions; not rarely they form mixed colonies with the above species. Noted in all steppe sectors of the reserve, the buffer zone and in Tsasucheisky pine forest, surely found in the *Valley of Dzeren.*

Order – LAGOMORPHA

Family Ochotonidae

13. Daurian pika – *Ochotona dauurica* Pallas, 1776

A common or numerous species, in some years in some sectors — a few in numbers species. Usually the density of dwelling holes differs in years and in different sites from 0 to 5-7 holes per 1 ha. In some years in local sites up to 10-20 dwelling holes/ha can be (i.e. herb-stipa steppe on the knob along the western shore of the Zun-Torey in 2010) or even to 40-50 (flank of the Imalka floodplain in 2010, the steppe shore of Lake Butyvken in 2011). It inhabits most of the steppe biotopes of the reserve and the buffer zone including large islands of Lake Barun-Torey and the *Valley of Dzeren* zakaznik. In Tsasucheisky pine forest the pika is common at the edges, on openings and old burnt areas.

Family Leporidae

14. Tolai hare – *Lepus capensis* L., 1758

A common, in the part of the territory or in some periods rare, species. Found in all parts of the protected areas. Density in wintertime in a number of local habitats (the northern shore of Lake Zun-Torey, channels of the Utochi, mountain area Bulum, edges of Tsasucheisky pine forest) in some years amounts to 2-6 indiv./10 ha, in the rest of the area the population density is lower. Maximum density in a large part was registered in 1997 at the northern shore of Lake Zun-Torey — 3.02 indiv./10 ha. On the dry land it is found everywhere including large islands and wet parts of the river floodplains. In depressions of the relief and in habitats with good protective conditions the population density is far higher than in upland sites.

15. Mountain hare – *Lepus timidus* L., 1758

In the *Tsasucheisky bor* zakaznik and the adjacent Onon river floodplain single meetings are noted in some years. Not found in the reserve.

Order PREDATORS – CARNIVORA

Family Canidae

16. Corsac fox – *Vulpes corsac* L., 1768

In the reserve, its buffer zone and in the *Valley of Dzeren* zakaznik the numbers vary between high (1988–1992) and low (1998–2005), in some years in some sectors there are no corsacs, in Adon-Chelon sector rare in the periphery of the buffer zone; in the *Tsasucheisky bor* zakaznik the species is very rare on the edges of the pine forest. Found mainly in flat steppe biotopes, nearby cattle-breeding encampments.

17. Red fox – *Vulpes vulpes* L., 1758

Common, in some years numerous, in all the protected area. Density in the *Tsasucheisky bor* zakaznik varies between 0.2 and 1.4 indiv./1,000 ha, in the reserve and the *Valley of Dzeren* zakaznik in the years of high numbers of rodents — several times larger. Maximum density was registered to the north of Lake Zun-Torey in 1997 — 38 individuals/1,000 ha. Inhabits all biotopes of dry land. In wintertime penitrates the islands, on large ones can stay for summer. Dynamics of the numbers is not as sharp as that of corsac fox and raccoon dog.

18. Gray wolf – *Canis lupus* L., 1758

Common in all the protected area, in some years numerous in the Uldza floodplain and at the state border westward of Lake Barun-Torey, as well as in Tsasucheisky pine forest, in the rest of the parts until 1998 was very rare or single calls were noted. In the following years the numbers increased. In 1992–2013 in Tsasucheisky pine forest 17 to 36 animals lived, and in the Uldza floodplain — 9 to 20-22. The total numbers in the protected areas in the winter 1996/97 amounted to 65–75 heads, and it seems to be maximum. Found in all biotopes of dry land, and in the period of ice formation — also on the ice and islands of the Torey lakes.

19. Raccoon dog – *Nyctereutes procyonoides* Gray, 1834

Appeared on the Torey lakes in 1956 (Peshkov, 1967). Till early 2000s was common in the reserved area and the buffer zone, in some places numerous, in Tsasucheisky pine forest rare. With the beginning of drought and after very snowy winters of 2001 and 2003 died out on the Torey lakes, some years later there were no raccoon dogs in Tsasucheisky pine forest either. Since foundation of the *Valley of Dzeren* zakaznik in 2011 the species has not been registered on its territory.

Family Mustelidae

20. Mountain weasel – *Mustela altaica* Pallas, 1811

The numbers vary from very low to high. In 1990s it was noted only three times: at the Utochi channel, in Adon-Chelon mountain area, and in the hills northward of Lake Zun-Torey. In the latter site (Gulzhenginsky stationary site of anti-plague service) the percentage of entrapments in 1943-1952 varied from 0.003 to 0.09 (Peshkov, 1954), in 1990 it amounted to 0.02%, in 1991 – 0%, in 1992 – 0% (S.A. Hamaganov, hand-written annual reports of the stationary site). With the beginning of the dry period the numbers started to increase. In 2011–12 the species was found everywhere, in some places with high density. In 2012 on cobb Myrgen and in the interlake area the density was 15.1 individuals per 1,000 ha. Occasionally noted in Tsasucheisky pine forest, registered in the most part of the *Valley of Dzeren* zakaznik. Distribution and numbers greatly depend on abundance of Daurian pika and Mongolian gerbil.

21. Least weasel – *Mustela nivalis* L., 1766

It was noted in most of the reserve's sectors and in the zakazniks but is rare everywhere. Meeting of traces in the surroundings of the Torey lakes became often in 2010–11. In 2012 the population density in the reserve and the buffer zone amounted to 0.05 indiv./1,000 ha, and in the *Valley of Dzeren* — 0.07 indiv./1,000 ha; in 2013 it decreased considerably, especially in the reserve.

22. Ermine – *Mustela erminea* L., 1758

Seems to come extremely rarely to Tsasucheisky pine forest. Two meetings are noted: in 1988 — in the Onon river floodplain and in 1993 — in Nizhny Tsasuchey (A.P. Borodin, personal information).

23. Siberian weasel – *Mustela sibirica* Pallas, 1773

A rare species. In the zakaznik during winter census 1-2 traces were registered for 10 km of the route. In the reserve it was found regularly only in the mouth of the Uldza (15-20 traces for 10 km), at the southern shore of Lake Barun-Torey and seldom along the Imalka floodplain, but in recent years traces have not been registered already.

24. Steppe polecat – *Mustela eversmanni* Lesson, 1827

In the middle of this century - numerous (Peshkov, 1954), in 1990s – rare, and by the end of the 2010s it is a common species again in all steppe parts of the reserve and the *Valley of Dzeren* zakaznik. Periodically noted in Tsasucheisky pine forest.

25. Wolverine – *Gulo gulo* L., 1758

Coming of this species was noted in the winter 2011/2012. The animal went from the northern shore of Lake Barun-Torey across the low hills northward of Lake Zun-Torey and further on to the south-east over the *Valley of Dzeren* zakaznik almost to Zabaikalsk settlement.

26. Asian badger – ***Meles leucurus*** **Hodgson, 1847**

A common, in some mountain areas and in some years — numerous, in dry periods - few in numbers species in all the protected areas. Density of dwelling holes in some parts (mountain area Bulum, the right bank terrace of the Imalka river at the state border) in favorable years amounts to 6-10 per 1,000 ha. Found everywhere, except the islands of the Torey lakes, in wet periods and in some places — in some mountain areas — in dry years.

Family Felidae

27. Pallas' cat – ***Felis manul*** **Pallas, 1776**

In 1990s a very rare species in the most part of the reserve and buffer zone. Meetings were fixed only in the hummocks to the north of Lake Zun-Torey where within the protected area, seemingly, lived not more than 4-10 individuals. Common in the sector of the reserve and buffer zone in the mountain area Adon-Chelon. There the density of the cats' population in the unfavorable for forage year 1995 was 1-2 indiv./1,000 ha but in the next years it increased noticably. By 2008-11 the numbers in the Interlake area and to the north and east of the Torey lakes had increased considerably. In early 2011 only on cobb Myrgen about 40-45 individuals lived with the population density 17.6–19.5 indiv./1,000 ha. Totally in the reserve and buffer zone that year not less than 200 cats habitated. In 2012–13 the number of the cats fell greatly following the depression in the numbers of pikas and most of rodent species. In Tsasucheisky pine forest in two decades the species was noted only on the south-eastern edge and in the northern part. It lives permanently on the territory of the *Valley of Dzeren* zakaznik nearby the Borzya river and to the south of the Nerchinsky mountain range.

28. Eurasian lynx – ***Lynx lynx*** **L., 1758**

A very rare species in the zakaznik in a wet period. In the reserve single calls were noted including in Adon-Chelon sector in early 2014. The numbers in Tsasucheisky pine forest in 1990s were not more than 6-10 individuals. In the last 10-12 years was not found any more.

Order ARTIODACTYLA

Family Suidae

29. Wild boar – ***Sus scrofa*** **L., 1758**

It comes very rarely to the reserve and the zakaznik (in 1992–2002 five meetings were noted in the zakaznik and two meetings in the reserve). It penetrates there from Mongolia and Durulguy forest estate. In 2001 in the shallow waters of the Uldza 14-15 individuals lived in summer. Calls are usually caused by strong fires in the areas of permanent habitation in Mongolia. In the later dry years it was registered only once in the zakaznik.

Family Cervidae

30. Red deer – ***Cervus elaphus*** **L., 1758**

Very rare in Tsasucheisky pine forest; in the reserve (shallow waters of the Uldza, the southern shore of Lake Zun-Torey) only single calls from Mongolia are registered. In the pine forest till 1997–1998 almost every year up to 5-10 animals habitated. Afterwards reliable meetings were not registered. Staying of some groups in the forest was linked to summertime in wet years.

31. Siberian roe deer – ***Capreolus pygargus*** **Pallas, 1771**

Numerous in Tsasucheisky pine forest; numerous, common or rare in the shallow waters of the Uldza; common or rare to the west of Lake Barun-Torey and to the east of Lake Zun-Torey within the reserve and the buffer zone. Common in the mountain area Adon-Chelon. In low water periods it sometimes winters in shallow waters of the Uldza. The numbers in the *Tsasucheisky bor* zakaznik in 1990–2013 varied gradually increasing within 2,800–6,770 heads, the density - from 48 to 117 individuals per 1,000 ha. In the *Valley of Dzeren* zakaznik it is found sporadically, mostly near the Borzya river and on the branches of the Nerchinsky range.

Family Bovidae

32. Mongolian gazelle – ***Procapra gutturosa*** **Pallas, 1777**

On the reserve's territory until 2000 rare, later — a common species. In the winter 2000–2003 and in some winters of the following years — a numerous and even very numerous species. In the years of extreme far migrations (2001, 2010 and 2013) the species winters in Tsasucheisky pine forest. In the part of the reserve and buffer zone westward of Lake Barun-Torey and southward of the Imalka river since 1992 Mongolian gazelles have started breeding. Until 1999 they lived there permanently only from April to September, and wintered, with rare exceptions, in the adjacent part of Mongolia. Then their staying became round-the-year. Since 2001 gazelles have been living also in the other parts of the reserve and the buffer zone, very rarely — in the Forest-steppe sector and on Adon-Chelon. The numbers of the local groupings before the breeding season were: in 1993 – about 10 heads, in 1994 – 50–60, in 1995 – 25–30, in 1996 – 30–35, in 1997 – 20–25, in 1998 – 15–20, in 1999 – 73–85, in 2000 – 44–58, in 2001 – 345–380, in 2002 – 305–330. After that a stable growth of the numbers started. By the fall 2013 in the reserve, its environs and on the territory of the newly founded *Valley of Dzeren* zakaznik about 4,200 local gazelles lived.

Order RODENTS – RODENTIA

Family Sciuridae

33. Brown squirrel – *Sciurus vulgaris* L., 1758

More often — rare, in some periods — a common species in Tsasucheisky pine forest. In the reserve it inhabits only the Forest-steppe sector. In the pine forest it started to be found regularly only since 1992–93, before that single calls were noted. In 1996–97 in the forest some thousands of squirrels lived. In the following years the numbers fell because of fires, among other factors. By 2013 the numbers have become very small.

34. Siberian chipmunk – *Tamias sibiricus* Laxmann, 1769

The species was common in the first half of the 20th century in the western part of Tsasucheisky pine forest (Nekipelov, 1961). Since the foundation of the zakaznik meetings have not been registered. However, in 2013 a chipmunk was found in the Onon valley nearby the north-western edge of the zakaznik at Bolshevik village.

35. Long-tailed souslik – *Spermophilus undulatus* Pallas, 1778

A rare species in the *Tsasucheisky bor* zakaznik; in the reserve and in the *Valley of Dzeren* it is not found. Its rare settlements are located at the northern edges of the pine forest. V.E. Kiriliuk (2003) in 1990s noted the animal at Lake Butyvken in Tsasucheisky pine forest but presently only Daurian souslik is found there.

36. Daurian souslik – *Spermophilus dauricus* Brandt, 1844

In 1994–2001 it was a rare and very rare species in the reserve, earlier it was common. In the buffer zone and the *Valley of Dzeren* zakaznik it is rare, in some places common, in the *Tsasucheisky bor* zakaznik it is known in the western part (Lake Butyvken). In 2002 growth of the numbers and distribution were noted. The dwellings are mainly in steppe parts with vegetation damaged by livestock in the environs of human settlements and cattle-breeding encampments, as well as at the sides of field roads.

37. Siberian marmot – *Marmota sibirica* Radde, 1862

A rare species in the reserve and the buffer zone (mountain area Bulum, hummocks to the north-east of Lake Zun-Torey, Adon-Chelon). The total numbers on the territory of the reserve and its buffer zone in 1992–2002 varied approximately from 30 to 60 adult animals, then the numbers increased up to 80-120 individuals thanks to joinment of the Adon-Chelon sector and expansion of the buffer zone, by 2013 the number were about 150-200 individuals. In the *Valley of Dzeren* zakaznik in 2013 more than 5 thous. individuals were censused.

Family Allactagidae

38. Siberian jerboa – *Alactaga sibirica* Forster, 1778

A common species. The numbers vary in years insignificantly. The density of holes in habitats varies from 0.2 to 3.6 per 1 ha. In the reserve, its buffer zone and the *Valley of Dzeren* zakaznik it inhabits all types of dry open biotopes, in Tsasucheisky pine forest — in the edges, large openings, along roads. The numbers somewhat increased in 2012 on the background of drought and depression of the other rodent species.

Family Cricetidae

39. Transbaikal hamster – *Cricetulus pseudogriseus* Iskhakova, 1974

In 1993 and at the following karyotypic investigations habitation of the form *C. Pseudogriseus* in the protected areas was identified, the form is defined in the modern systematics as an allopatric independent species or as a «semispecies» of the striped hamster (*C. Barabensis*). Identification was done with chromosome sets of 10 individuals caught in the reserve, zakaznik and outside them (Korablov et al., 2003). The nearest locations of the form *C. Barabensis* are on the northern bank of the Onon river (Korablov, 2013). A common species. Relatively evenly distributed in all types of steppe biotopes and agrocenoses. Being caught with the lines of break-back traps the number of entrapments amounts to 10-12%. If caught with grooves, ia in steppes and old burnt areas of Tsasucheisky pine forest amounts to 5-6, and in dry reeds even to 17. With the method of marking the absolute index of abundance in appropriate stations was obtained in the second half of summer at Utochi cordon in 2011 — 32 indiv./10 ha.

40. Campbell's hamster – *Phodopus campbelli* Thomas, 1905

A rare, in some places common, species. Index of abundance in feather-grass steppes usually amounts to 2-4. Noted in steppe biotopes in all the sectors of the reserve. In Tsasucheisky pine forest it is not noted, although in the past the finds were known at Nizhny Tsasuchey village (it is likely, not in the pine forest proper) (zoological museum of the Irkutsk State University).

41. Ruddy vole – *Clethrionomys rutilus* Pallas, 1779

A common, in some years rare, species in Tsasucheisky pine forest (ia up to 3-5) and in the forest groves of Adon-Chelon.

42. Grey-sided vole – *Clethrionomys rufocanus* Sundevall, 1846

The vole was noted in Tsasucheisky pine forest in the first half of the 20th century (Fetisov, 1944). Since the foundation of the zakaznik the species has not been registered.

43. Muskrat – *Ondatra zibethicus* L., 1766

A common, and since 1997–98 – rare, species in the reserve and buffer zone. Since 2003–2004 till 2011 the species was not noted. There are no muskrats in the zakaznik. Censuses were not conducted. The muskrat habitated in the Uldza river delta, in the mouth and swampy parts of the Imalka river, at the maximum distribution in the periods of high water it was found at the southern shores of Lake Barun-Torey. Its disappearance is connected with drying of Lake Barun-Torey and ceasing of the flow from the Uldza and Imalka. In the years of high water, i.e. in 2013, it is common in the Borzya river floodplain within the *Valley of Dzeren* zakaznik.

44. Brandt's vole – *Lasiopodomys brandti* Radde, 1861

A rare or common species in most of the biotopes of the reserve, except the Forest-steppe sector and Adon-Chelon. In some years it is extremely numerous in certain parts of the steppe and in the fallow lands southward of the Torey lakes and in the Interlake part. The numbers are subject to sharp fluctuations. In 1996–2002 the Brandt's vole preserved only in separate small colonies-reserves. Density in the key habitats in the years of high numbers amounts to 8-20 dwelling holes per 1 ha, and in some parts several times more.

45. Maximovich's vole – *Microtus maximowiczii* Schrenck, 1859

Permanently inhabits the shore of Lake Butyvken in Tsasucheisky pine forest (Kovalskaya et al., 2012). A single meeting was noted also in an old burnt area of the pine forest at N. Tsasuchey village.

46. Far-eastern vole – *Microtus fortis* Buchner, 1889

A common, in some years numerous, species in the appropriate stations of the reserve and buffer zone. In wet periods it inhabits the river floodplains and adjacent meadow steppes, some near-shore parts overgrown with reed over the perimeter of the Torey lakes. With the drought it disappeared after the habitats transformation. In 2008–2010 at Utochi channel it was caught extremely rarely (ia ~ 1). By 2011 in the reserve with low numbers it was noted only in the shallow waters of the Uldza river (ia up to 6). By 2013 it is known again in Utochi channel.

47. Mongolian vole – *Microtus mongolicus* Radde, 1861

A common or rare species. Found in different sectors of the reserve and buffer zone in the habitats with meadow vegetation. In Tsasucheisky pine forest the species is common on the shore of Lake Butyvken (in 2011 — a numerous species (more than 1,000 indiv./ha) in the near-shore biotopes) and in the shrubby old burnt areas (ia up to 10). On the Torey lakes it is most numerous in the meadows of the Uldza and Imalka floodplains (ia amounts to some tens).

48. Narrow-skulled vole – *Microtus gregalis* Pallas, 1779

The numbers vary. A common, in some years numerous, species in all the protected areas in steppe stations (ia is usually within 5–10). In 1994–2002, 2008 and 2013 depressions of the numbers were observed.

49. Daurian tsokor– *Myospalax aspalax* Pallas, 1776

In the reserve and buffer zone it habitates only within the Forest-steppe sector and the mountain area Adon-Chelon. Within the buffer zone of the Imalkinsky sector the southern boundary of the areal lies — along the left bank of the Imalka it goes down to the border watch tower nearby Lake Sataninskoye. In the zakaznik it is common (the population density of adult individuals is up to 20 indiv./10 ha). Habitats are confined to mesophillic herb and meadow steppes, and in the pine forest — to forest edges, openings, light woods.

Family Gerbillidae

50. Mongolian gerbil – *Meriones unguiculatus* Milne-Edwards, 1867

A common, locally and occasionally - numerous, species. In the area of the Torey lakes the colonies are situated in fallow lands, along the exclusion zone of the state border, on the roadsides, sand blowouts, on the hills slopes northward of Lake Zun-Torey, on the near-shore alluvial bars of the lakes, old spoil banks of the narrow-gauge railway, etc. Since 2006–07 till 2010 the numbers increased fast in the iterlake part, the gerbil distributed to the overgrown parts of the bottom of the Barun-Torey and on the islands. The greatest numbers were in fallow lands overgrown with sagebrush and colza where on average were more than 1 entrance to the hole of one or another function per 1 sq.m. With those huge numbers by spring of the next year gerbils (as well as their favourite sage) disappeared from such parts altogether. But usually density of the holes amounts to 10-30/ha. Since 2011 the numbers started to decrease.

Family Muridae

51. Harvest mouse – *Micromys minutus* Pallas, 1771

Sometimes common, sometimes rare in the reserve, buffer zone and in Tsasucheisky pine forest. In the *Valley of Dzeren* zakaznik it has not been noted yet. Inhabits the river floodplains and the near-shore stripe of the Torey lakes, mainly in thickets of cheegrass. Since 2008 till 2013 in the reserve and its buffer zone it was noted once, in the years of high water the mouse was a common species. In Tsasucheisky pine forest in the same years the numbers varied amounting to the ia – 2–3.

52. Korean field mouse – *Apodemus peninsulae* Thomas, 1907

A rare species. Inhabits small forest groves in the Adon-Chelon sector and Tsasucheisky pine forest.

53. House mouse – *Mus musculus* L., 1758

In the wild it is a rare species, in houses and other constructions it is common. Outside human constructions it is found mostly in wet biotopes on the lakes shores.

54. Brown rat – *Rattus norvegicus* Berkenhout, 1769

A rare species. In the wild it is not noted. Regularly found in cattle-breeding encampments and in villages located in the buffer zone, and, as an exception, in the reserve.

References

Bazhenov, Yu. 2012. Fauna and structure of small mammals' communities in the *Tsasucheisky bor* federal zakaznik. In *Newsletter of North-Eastern scientific center of Far-Eastern branch, RAS*. 2: 29-33.

Cherkasov, A.A. 1867. Notes of a hunter of East Siberia. S-Petersburg: S.V. Zvonaryov's publishing house.

Fetisov, A.S. 1944. Rodents of South-East Transbaikalia. In *Newsletter of Irkutsk state anti-plague institute of Siberia and Far East*. 5: 198-215.

Fetisov, A.S. & Khrustselevsky, V.P. 1948. Mammals of South-East Transbaikalia. In *Papers of Irkutsk university*. 3: 3–15.

Hamaganov, S.A. Zoological reports of Gulzhenginsky stationary site of Chita anti-plague station of the years 1990, 1991, 1992 (manuscripts).

Kiriliuk, V. 2003. Annotated list of mammals of the *Daursky* biosphere reserve and the *Tsasucheisky bor* zakaznik. In *The Terrestrial vertebrates of Dauria*. 7-19. Chita: Poisk.

Kuznetsov, B. 1929. Rodents of East Transbaikalia In *Newsletter of association of scientific research institutes at faculty of physics and maths, Moscow State University*. Volume: 59-106.

Kovalskaya, Yu.M., Smorkachova, A.V. & Bazhenov, Yu.A. 2012. Distribution and hybridization of chromosomal forms of Maximovich's vole *Microtus maximowiczii* (Rodentia, Arvicolinae) in the Onon river basin (Transbaikalia). In *Current problems of contemporary theriology: proceedings of reports*. 57.Novosibirsk.

Kozhurina, E.I. 2009. Notes of fauna of Russia: systematics and distribution In *Plecotus et al*. 71(105): 11-12.

Korabliov, B.P., Kiriliuk, V.E. & Pavlenko, M.V. 2003. Amendment of boundary of Transbaikal hamster (*Cricetulus pseudogriseus*) distribution in Transbaikalia. In Биологийн хурээлэн эрдэм шинжилгээний бутээл. 22: 85–87. Ulaanbaatar.

Korabliov, V.P., Pavlenko, M.V., Bazhenov, Yu.A. & Kiriliuk, V.E. 2013. Distribution of hamsters of superspecies *Cricetulus barabensis* sensu lato (Rodentia, Cricetidae) in Zabaikalsky krai. *Zoological journal*. 92: 596-601.

Lamkin, V.F. & Puzansky, V.N. 2000. Scilly shrew. In *Red Book of Chita region and Aginsk buryat autonomous okrug: Animals*. 13-14. Chita: Poisk.

Nature Records of the *Daursky* Biosphere Reserve. SNBR *Daursky*. N. Tsasuchey, 1987–2013.

Nekipelov, N.V. 1961. Dispersal of mammals in South-East Transbaikalia and numbers of some species. *Bilogical collection*. 3–48. Irkutsk.

Pavlinov, I. 2006. Systematics of contemporary mammals. 2nd edn. Collected papers of Zoological museum, Moscow State University. Volume XLVII. *M*.: MSU.

Pavlov, E.I. 1935. Steppe rodents and their natural infestants of Zabaikalsky endemic plague center, their biology and role in spread of plague. In *Newsletter of Irkutsk state scientific research anti-plague institute of Siberia and Far East*. 1: 101-131.

Pavlov, E.I. 1948. Birds and animals of Chita region. Chita: Chitizdat.

Pavlov, E.I. 1949. Game animals of Chita region. Chita: Chita regional state publishers.

Pavlov, E.I. 1966. Some results of studying the nature of Transbaikalia. In *Report presented for acquiring scientific degree of Candidate of Biology based on all the published papers*. 1-28. Chita.

Peshkov, B.I. (1967). Distribution of raccoon dog in Chita region. *Protection and restoration of natural resources*. 1: 78–79. Chita.

Peshkov, B.I. 1954. Data on numbers of predators in South-East Transbaikalia. In *Newsletter of Irkutsk state scientific research anti-plague institute of Siberia and Far East*. 12: 217–223. Irkutsk.

Skalon, V.N. 1935. New data on fauna of mammals and birds of Siberia and Far-Eastern krai. In *Newsletter of State anti-plague institute of Siberia and Far East*. 2: 42-64.

Skalon, V.N. 1936. Further research on systematics and biology of mammals of Transbaikalian endemic plague centre. In *Newsletter of Irkutsk state s.-r. anti-plague institute*. 2: 151-213.

Shvetsov, Yu.G. 1990. Mammals of the Uldza river delta (East Transbaikalia). In *5th congress of All-Union Theriological society, AS of USSR*. 1: 154-155. Moscow.

Analysis of the Changing Characteristics and Factors Influencing the Dalai Lake Area

Zhang Na[1], Wu Liji[2]

[1] Dalai Lake National Nature Reserve Inner Mongolia, Hulun Buir, Inner Mongolia 021008, China
[2] Inner Mongolia Meteorological Bureau of Tongliao City, Tongliao, Inner Mongolia 028000, China

Abstract: In order to understand the effects of climate change on Dalai Lake and its characteristics, this study is based on analysis of 1991-2008 data collected on temperature, water area and water level in Dalai Lake area. Our findings suggest during the 18 year span from 1991 to 2008, the increased average air temperature and decreased precipitation has caused increased evaporation. In this area, there is a tendency towards winter getting colder and summer getting hotter; from 1991-2008, water area and water level decreased, and since 2000, the rate of decline has accelerated significantly, owing to the change in temperature and evaporation. Among all climate variables considered, the significant increase in fall temperatures is a key factor in the changes observed in the Dalai Lake wetlands.

Key words: *Dalai Lake, wetland, climate change, water area, water level*

Introduction

A lake is not only a sensitive indicator of climate and environmental change, but also an important part of the water circle in a river basin. Lake area and changes in water level can reflect changes in the water balance processes of a river basin (Lehner & Doll, 2004; Harris, 1994; Mason, Guzkowska & Rapley, 1994). Lakes also play an important role in economic development and maintaining regional environmental balance (Chi, Longhua & Na, 2010). Changes in lakes are affected by human activities and climate change (Boqiang, 1999). However, some research indicates that climate change is the main reason as it can affects on water resources over long time scales. Human activity is also a driving factor of lake change, but its effect occurs within short time of periods (Junli, Hui & Anming, 2011). Some research indicates water area has shown a positive correlation with annual precipitation (Lingling, Yushu & Pengshi, 2009), other researchers believe that shrinking wetlands are influenced by temperature and sunshine hours (Jin, Dongqing & Qingzhou, 2009). Research on Sailimu Lake and other lakes in eastern inner Mongolia and the northern Mongolia plateau, showed there is a relationship between changes in water level and precipitation in this area, and that glacial melt, induced by raising temperatures could indirectly increase water levels (Boqiang & Suming, 1994; Diandao, Liping & Qianjin, 2003). For Dalai lake, which is a fragile system, protecting the wetland is extremely important to maintain ecological balance and ensure sustainable development for humans and nature.

Dalai lake, so-called Hulun lake, it is not only the fifth largest fresh-lake in China, but also the largest fresh-lake in northern China. Dalai lake wetland and its surrounding grassland ecosystem are considered an ‘ecological security barrier’ in northern China as its wetland and waters serve an irreplaceable function. Recently, because of human activity, global CO_2 concentrations and CH_4 concentrations continue to increase, and in the past 100 years, the average global surface temperature increased 0.74^{0}C. Average surface temperature has increased 1.1^{0}C in China, making the rate of warming 0.22^{0}C/10 year (Kai, Bingbing & Lichun, 2011; IPPC, 2007). Affected by climate warming and drying, the Dalai lake water area and water area keep decreasing, and research has shown that under continuous drought, the water level of Dalai Lake has decreased by 0.3-0.5m (Yonghai, Jiancheng & Weiping, 2005). In order to understand the effect of climate change on Dalai lake, this paper investigates relevant climate change characteristics of the Dalai lake area over 18 years from 1991-2008, to provide a reasonable theoretical basis for the protection of Dalai Lake and its sustainable development.

Study area

The study area is located in the northeast of Inner Mongolia in Western Hulun Buir Plateau in the high latitudes, across Xin Baerhuzuoqi, Xin Baerhuyouqi, Man Zhouli, longitude is 117°00′10″-117°41′40″, north latitude is 48°30′40″-49°20′40″. The climate of this area is arid and semi-arid continental monsoon climate, typified by the long cold winter and the dry windy spring. Fall temperature decreased drastically and there is early frost.

Materials and Methods

Climate data is provided by Meteorological Bureau of Xin Baerhuzuoqi, Xin Baerhuyouqi, Man Zhouli, water area of Dalai lake is monitored by Remote Sensing techniques, which is provided by the Inner Mongolia Agriculture University (Biao, 2010).

Data analysis

SAS 9.0 and Excel mathematical statistics analysis software was used to analyse the data and undertake regression analysis. We calculated the climate tendency slope, using 2nd order polynomial to simulate the climate trends. In order to understand temperature dependent changes in Dalai lake area over time, we used regression analysis. do regressive relationship between average temperature of different period, maximum temperature and minimum temperature of recent 18 years, from 1991 to 2008.

Results

The characteristics of inter-annual temperature

Linear regression analysis indicates annual average temperature has increased over time (Table 1). In the 18 year period of the study, annual temperature of this area increased 0.193^{0}C, average temperature of summer and fall, maximum temperature and minimum temperatures are rising volatility. Spring temperature fluctuates greatly, however, a trend of changes showed no obvious but its change trend is not obvious. Spring maximum temperature has risen more obviously, while Spring minimum temperature has decreased. Average temperature, maximum temperature and minimum temperature of winter has decreased. The whole temperature picture shows that summer is becoming hotter and hotter, and winter is becoming colder and colder; as can be seen from regressive equation, change in slope of average temperature of spring, summer, fall, winter, winter half year and summer half year is -0.09, 0.84, 1.31, -0.42, 0.89, 0.67^{0}C·（10a）$^{-1}$ respectively. Average temperature increase is due to the increase of summer half average temperature, summer half maximum temperature, summer half minimum temperature. There is significant correlation between summer half average temperature, annual maximum temperature and annual (P < 0.05), there is very significant correlation between fall average and annual temperature (P<0.01). The average temperature, maximum temperature, minimum temperature correlation is not significant with annual. This issue indicated that the increase of annual average temperature is due to the increase of summer half temperature, and the increase maximum temperature is the main factor affecting the increase of average temperature, the increase of fall average temperature caused the summer half temperature increased.

Table1. Regressive relationship between time and average temperature, maximum temperature and minimum temperature

Climate variables	Linear regression equation	R^2	P value
Annual average temperature	T_{ave-a} = 2.05+0.0107year	0.0078	0.7268
Winter half av. temperature	T_{ave-wh} = -10.735-0.0667year	0.0721	0.2664
Summer half av. temperature	T_{ave-sh} = 14.402+0.0892year	0.2936	0.0166*
Spring average temperature	T_{ave-sp} = -5.9348-0.009year	0.0008	0.9116
Summer average temperature	T_{ave-su} = 17.628+0.0836year	0.1935	0.0677
Fall average temperature	T_{ave-f} = 10.478+0.1311year	0.3816	0.0063**
Winter average temperature	T_{ave-w} = -15.554-0.0415year	0.0212	0.5643
Annual maximum temperature	T_{max-a} = 21.516+0.1071year	0.2908	0.0209*
Spring maximum temperature	T_{max-sp} = 3.1842+0.1147 year	0.1431	0.1102
Summer maximum temperature	T_{max-su} = 21.858+0.0384year	0.0204	0.5600
Fall maximum temperature	T_{max-f} = 18.981+0.1182year	0.1909	0.0638
Winter maximum temperature	T_{max-w} = -8.8491-0.0598year	0.0197	0.5667
Annual minimum temperature	T_{min-a} = -19.972-0.1064year	0.0605	0.3254
Spring minimum temperature	T_{min-sp} = -13.961-0.1623year	0.0887	0.2155
Summer minimum temperature	T_{min-su} = 12.914+0.0118year	0.0021	0.8533
Fall minimum temperature	T_{min-f} = 2.1614+0.0318year	0.0126	0.6469
Winter minimum temperature	T_{min-w} = -19.972-0.1065year	0.0705	0.2719

*Significance code: *: P<0.05,**: P<0.01*

Changing trends of precipitation

Figure1 shows the precipitation change trend of Dalai Lake area from 1991-2008, using 2nd order polynomial regression to simulate the precipitation trends. As can be seen from Figure 1, the overall precipitation decreased during the 18 years of the study, spring precipitation and winter precipitation increased, but summer precipitation and fall precipitation decreased. Summer and fall precipitation accounted for more than 80% of annual precipitation, so annual precipitation decrease is due to summer and fall precipitation decrease. Annual precipitation decreased 98.7mm over the study period, with fall precipitation declining significantly, its decreasing slope is -4.37mm·a^{-1}. Summer precipitation decreased more slowly, its decreasing slope is -1.98mm·a^{-1}. Increasing slope of spring and winter precipitation is 0.46-0.33mm·a^{-1} respectively. A snowstorm happened in Dalai lake area causing the increasing spring and winter precipitation.

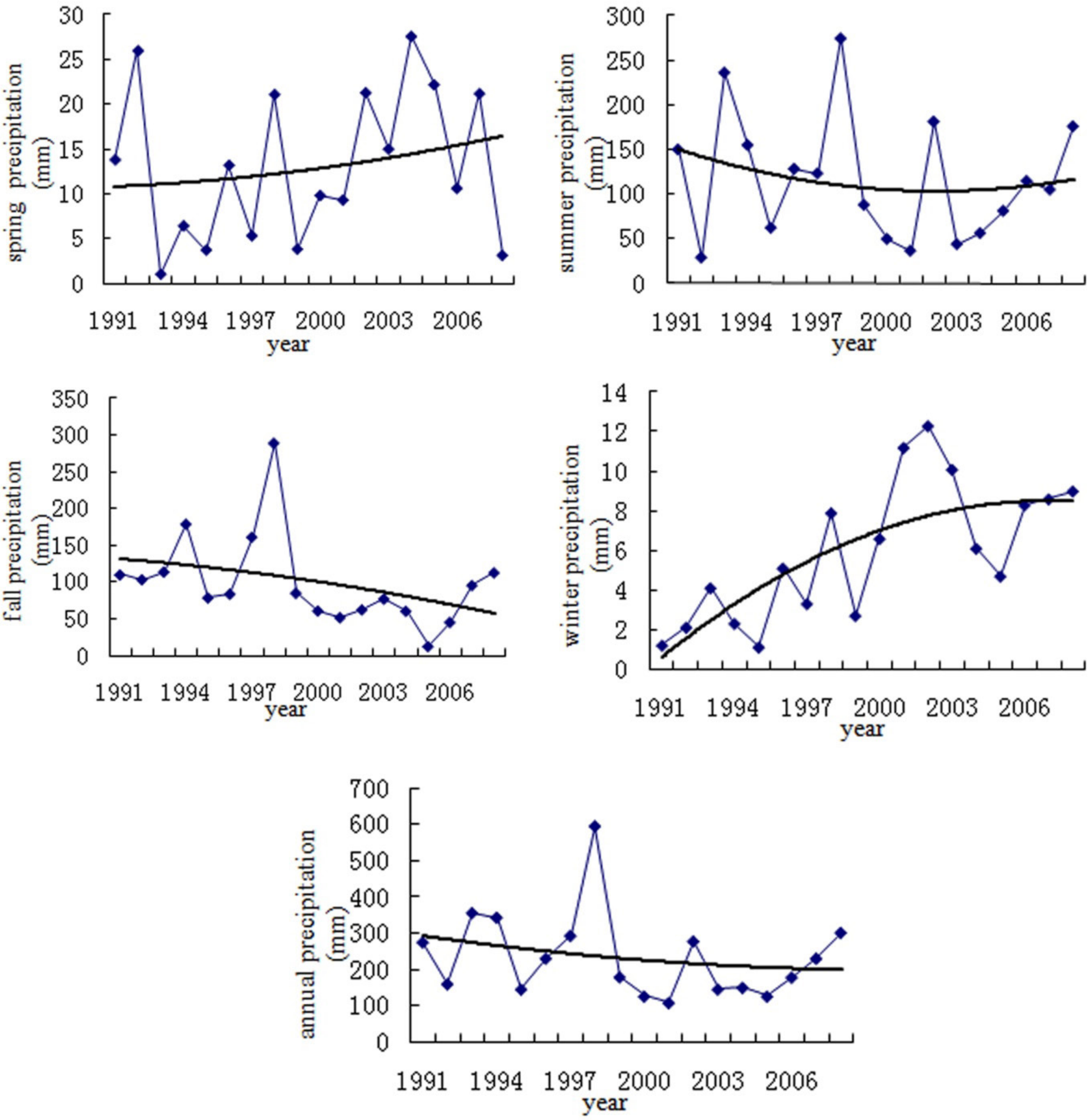


Fig.1 Variations of spring, summer, fall, winter and annual precipitations in Dalai Lake

Changing trends of evaporation

Figure 2 shows the changing trends in precipitation of Dalai Lake area from 1991-2008, and uses 2nd order polynomial to simulate the evaporation trends. As can be seen from Figure 2, overall evaporation increased during the study period, with spring, summer and fall evaporation increasing to different degrees; fall evaporation increase was more obvious than the other two seasons, while the increasing rate of spring evaporation was slower, and the increasing trend of summer evaporation was not obvious. Winter evaporation decreased. As a result, the high increase in fall evaporation is the main reason for increasing annual evaporation. In this recent 18 years, annual evaporation increased 596 mm, with fall evaporation increasing slope is 24.16 $mm \cdot a^{-1}$, with the increasing slope of summer and fall evaporation is 4.71, 3.00 $mm \cdot a^{-1}$ respectively, but various slope of winter evaporation is -0.46 $mm \cdot a^{-1}$, with the emergence of colder winter and snowstorm increasing, winter evaporation decreased.

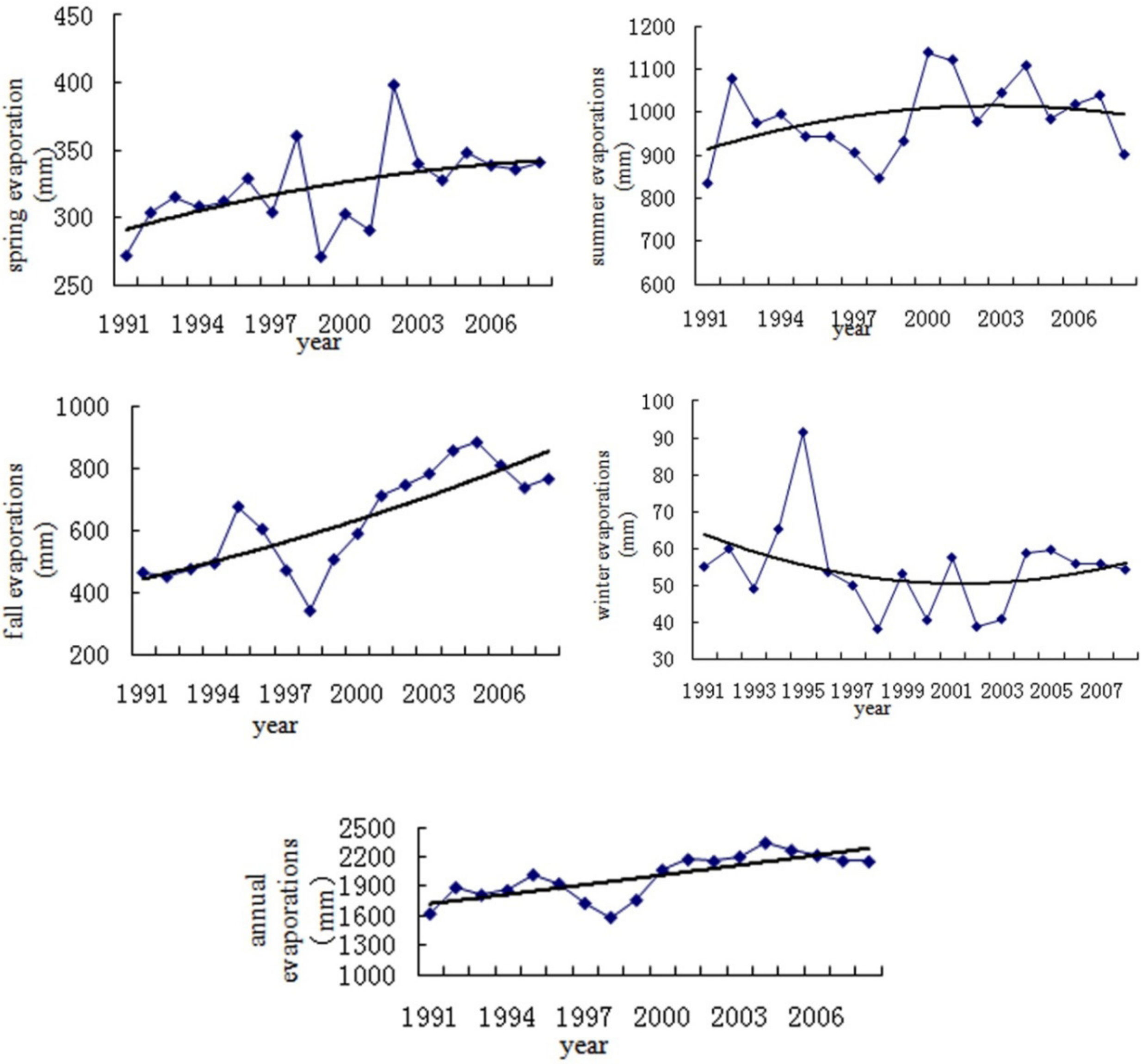


Fig. 2 Variations of spring, summer, fall, winter and annual evaporations in Dalai Lake

The relationship between the trend of water area, water level and temperature, precipitation, evaporation

As can be seen from Figure 3, the change of water area is consistent with the change of water level. Before 2000, the change in water level and water area of Dalai lake was not obvious, after 2000, decreasing rate accelerated obviously. Compared with water area, water level decreased more significantly, from 1991—2008, water area decreased 316.68km^2, and water level decreased 3.94m. After 2000, water area decreased 275.07 km^2, and water level decreased 3.27m. The drop accounted for 86%, 83% of total respectively, so the change of water area and water level is due to the change after 2000.

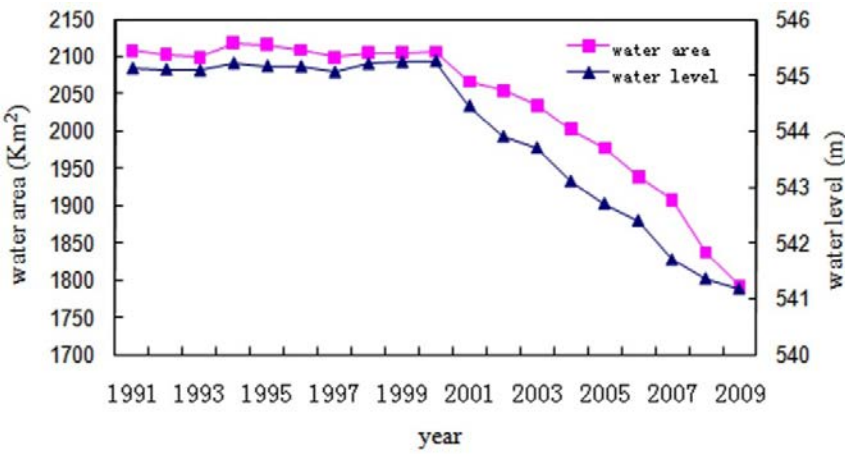


Figure 3. Variations of water area and water level of Dalai Lake

Table 2 shows the correlation analysis between maximum temperature, minimum temperature, average temperature and water level, water area of Dalai lake. As can be seen from table 2, there is positive correlation between minimum temperature, spring average temperature, winter average temperature and water level, but this is not significant; there is a positive correlation between minimum temperature and water area, but this is not significance; there is a negative correlation between other factors and water level, water area include statistical output, and there is significant negative correlation between fall temperature and water level (P < 0.05). As fall temperature increased, water level and area decreased. There is a highly significant negative correlation between fall temperature and water area (P < 0.01). There is no significant correlation between other temperature and water area, so fall temperature is the main factor affecting water level and water area of Dalai lake.

Table 2. Coefficient relationship between water level, and water area of Dalai Lake and seasonal temperature

Temperature	**Water level**		**Water area**	
	Coefficient correlation	**Significance (*P*)**	**Coefficient correlation**	**Significance (*P*)**
Annual average temperature	-0.09218	0.7074	-0.3695	0.1313
Max temperature	-0.24109	0.3201	-0.33239	0.1778
Min temperature	0.07432	0.7624	0.05852	0.8176
Spring average temperature	0.03575	0.8845	-0.07591	0.7647
Summer average temperature	-0.37652	0.1121	-0.24187	0.3336
Fall average temperature	-0.52074*	0.0223	-0.6208**	0.006
Winter average temperature	0.10795	0.66	-0.10627	0.6747

*Significance code: *: P<0.05, **: P<0.01*

Table 3 shows the correlation analysis between precipitation, water level, and water area of Dalai lake. As can be seen from Table 3, there is no significant correlation between annual precipitation, spring precipitation, summer precipitation, winter precipitation and water level or water area of Dalai lake. There is a significant negative correlation between winter precipitation and water area (P < 0.05), and a highly significant negative correlation between winter precipitation and water level (P < 0.01). With the increase in annual precipitation, water area and water level decreased. Winter precipitation accounts for 5% of annual precipitation, and in recent years, because of regular snowstorms in this area, the winter precipitation has increased. This correlation relationship between winter precipitation and water area, water level is accidental, so precipitation is not the main factor affecting water level and water area.

Table 3. Coefficient relationship between water level, and water area of Dalai Lake and seasonal precipitations

Precipitations	**Water level**		**Water area**	
	Coefficient correlation	**Significance (*P*)**	**Coefficient correlation**	**Significance (*P*)**
Annual precipitations	0.18523	0.4477	-0.06746	0.9927
Spring precipitations	-0.1845	0.4496	-0.14437	0.5676
Summer precipitations	0.0233	0.9246	0.01279	0.9598
Fall precipitations	0.39456	0.0946	0.29974	0.2269
Winter precipitations	-0.63278**	0.0036	-0.50409*	0.0329

*Significance code: *: P<0.05, **: P<0.01*

Table 4 shows the correlation analysis between evaporation and water level, water area of Dalai Lake. As can be seen from Table 4, there is a highly significant negative correlation between annual evaporation and water level (P < 0.01), there is a significant negative correlation between spring evaporation and water area (P < 0.05), there is a very significant negative correlation between fall evaporation and water level and water area (P < 0.01). There is no significant correlation between other evaporation periods and water level or water area of Dalai lake. With the increase of evaporation, water level and water area decreased. So evaporation has become another important factor affecting water level and water area of Dalai lake, especially fall evaporation which is more significant.

Table 4. Coefficient relationship between water level and water area of Dalai Lake and seasonal evaporations

Evaporations	Water level		Water area	
	Coefficient correlation	Significance (*P*)	Coefficient correlation	Significance (*P*)
Annual evaporations	-0.67946**	0.0014	0.0754	0.0944
Spring evaporations	-0.51605*	0.0237	-0.41518	0.0866
Summer evaporations	-0.11909	0.6273	-0.09925	0.6925
Fall evaporations	-0.74573**	0.0002	-0.69421**	0.0014
Winter evaporations	0.20954	0.9045	0.03044	0.9046

*Significance code: *: P<0.05, **: P<0.01*

Discussions

In this paper, we analyzed 18 year climate data and the results show that climate change in the Dalai lake area is a warming drying trend of temperature increase, precipitation decrease and evaporation increase, which is consistent with the majority of the world showing global warming trend (Shaowu & Jinlin, 1995). Climate change is not a uniform process, changes in the maximum temperature is more obvious than the minimum temperature. Summer half the average temperature changed more significantly than winter half the average temperature, and there is a significant correlation in fall temperature among each year, so temperature increasing in Dalai lake area is caused by summer half temperature and maximum temperature keep increasing. The most significant increasing temperature is fall temperature, this was consistent with other study (Huiying, Chengcai & Henghe, 2007). This may be due to the fall temperature gradually increasing since 2005, winter temperature in Dalai lake area is decreasing, but summer is hotter, winter is colder. There is significant correlation between water area, water lever of Dalai lake and fall temperature, so, increasing temperature could cause water area, water level of Dalai lake to decreased. This issue is consistent with the issue of Qinghai lake (Shenbing, Kailong & Wenyu, 2011).

The precipitation of Dalai lake area decreased, the main reason being precipitation decreasing in of summer half year decreased, fall precipitation decreased more significantly, there is little relationship between precipitation and water area, water level of Dalai lake, this issue is consistent with the issue of Qinghai lake (Shenbing, Kailong & Wenyu, 2011). Winter precipitation increased, this may be due to winter snow disaster occurred frequently, but winter precipitation takes a small proportion in annual precipitation and it plays little role in annual precipitation. Qing Boqiang (Boqiang & Suming, 1994) did a study on Dalai lake in last century, the results showed precipitation is the main factor affecting Dalai lake expansion, but with the climate becoming warmer and drier, precipitation has changed little. This study believes that precipitation is no longer the main factor affecting climate change.

Evaporations of Dalai lake increased, there is significant correlation relationship between annual evaporations and water area of Dalai lake, so water area declining is caused by climate warmer and drier which lead to evaporation increase. Water appeared negatively balanced, which lead to lake shrinking (Shijie, Wanchun & Weilan, 1998; Jiahu & Qun, 2004). Increase in evaporation is caused by fall evaporation increasing and there is a significant correlation between fall evaporation and water level and water area of Dalai lake. So the increasing evaporation is the key factor that causes water area and water level of Dalai lake decline, which is consistent with the issue of the other paper, which did research on lakes (Huiying, Liji & Wenjun, 2008). Temperature decreased, precipitation increased, evaporation decreased in winter and these changes coincide with the whole trend of climate change in this region, so this paper believes that fall evaporation increasing is the main factor of water area and water level decline.

Conclusions

This paper based on 18 years' remote sensing data and several years' measured data collected from research, the results showed, (1) in recent 18 years, water level of Dalai lake decreased 3.94 m, water area decreased 316.68 km^2, and the rate accelerated significantly after 2000; after 2000, both of them declined 3.27 m and 275.07 km^2 respectively. (2) The whole climate trend of Dalai lake showed warmer and drier climate of temperature increasing, precipitation declining, evaporation increasing. In this recent 18 year span, temperature increased 0.193^{0}C, precipitation declined 98.7 mm, evaporation increased 596 mm. Fall climate change is the main factor of annual climate change, and Dalai lake area showed the polarization of summer become hotter and hotter, winter become colder and colder. (3) Increasing temperature and increasing evaporation could cause the lake area to keep shrinking, the water level to keep declining. The increasing fall temperature and fall evaporation affect water area and water level of Dalai lake significantly. Climate warming and drying has become a main factor affecting water area shrinking and water level declining, so it is necessary to improve the Dalai lake wetland environment.

References:

Biao, 2010. The dynamic change of water based on spatial information technology for Hunlun lake in Inner Mongolia. Doctoral Dissertation, Inner Mongolia Agricultural University.

Boqiang, Q. & Suming, W. 1994. The recent expansion of Hunlun lake and its relation to warming global climate. *Oceanlogia Et Limnologia Sinica*, 25: 280-287.

Boqiang, Q. 1999. A preliminary investigation of lake involution in 20-century in inland mainland Asia with relation to the global warming. *Journal of Lake Sciences*, 11: 11-19.

Chi, Z., Longhua, H. & Na, Y. 2010. Variations in Ebinur lake area caused by human activities and climate change. *Marine Geology & Quaternary Geology*, 30: 121-126.

Diandao, M., Liping, Z. & Qianjin, W. 2003. Influence of the warm-wet climate on Sailimu lake. *Journal of Glaciology and Geocryology*, 25: 219-223.

Harris, A.R. 1994. Time series remote sensing of a climatically sensitive lake. *Remote Sensing of Environment*, 50: 83-94.

Huiying, Z., Chengcai, L. & Henghe, Z. 2007a. The climate change and its effect on the water environment in Hunlun lake wetland. *Journal of Glaciology and Geocryology*, 29: 765-801.

Huiying, Z., Liji, W. & Wengjun, H. 2008b. Inference of climate change to ecological and environmental environment in the Hunlun lake wetland and its surrounding areas. *Acta Ecologica Sinica*, 28: 1064-1071.

IPPC. 2007. Climate Change 2007: The physical science basis-summary for policymakers. Cambridge, UK: Cambridge University Press:18.

Jiahu, J. & Qun, H. 2004. Distribution and variation of lakes in Tibetan Plateau and their comparison with lakes and other part of China. *Water Resources Protection*, 6: 24-27.

Jin, C., Dongqing, L. & Qingzhou, M. 2009. The status and the causes of wetland degradation in the sources regions of Yangtze river and yellow river. *Journal of Arid Land Resources and Environment*, 23: 43-49.

Junli, L., Hui, F. & Anming, B. 2011. Spatio-temporal analysis of recent changes of lake area and lake water level at high mountains in central Asia. *Resources Sciences*, 33: 1839-1846.

Kai, Y., Bingbing, C. & Lichun, L. 2011. Characteristics of climate change and its impact analysis in Estuary wetland of Ming Jiang river. *Chinese Journal of Agro-meteorology*, 32: 79-82.

Lehner B, & Doll, P. 2004. Development and validation of a global database of lakes, reservoirs and wetlands. *Journal of Hydrology*, 296: 1-22.

Lingling, X., Yushu, Z. & Pengshi, C. 2009. Analysis on the changing characteristics and influencing factors of Pan Jin wetland during the past 20 years. *Journal of Nature Resources*, 24: 483-490.

Ming, L., Wanchun, L. & Weilan, X. 2006. Climatic change features of Tieling, Liaoning province in recent 45 years. *Meteorological*, 32: 84-91.

Mason, I.M., Guzkowska, M.A.J. & Rapley, C.G. 1994. The response of lake levels and areas to Climatic change. *Climatic Change*, 27: 161-197.

Shaowu, W. & Jinlin, Y. 1995. An analysis of global warming during the last one hundred years. *Scientia Atmospherica Sinica*, 19: 545-553.

Shenbing, Y., Kailong, L. & Wengyu, W. 2011. The effect of climate change on water area of Qinghai lake. Tje 28th annual of Chinese meteorological sociality-S11 meteorological and modern agriculture. Fujian: *Chinese meteorological society*: 597.

Shuqing, Z., Bo, Z. & Aihua, W. 2001. A study on the relationship between distributive variation of wetlands and regional climate change in Sanjiang plain. *Advance in Earth Sciences*,16: 836-841.

Shijie, L., Wanchun, L. & Weilan, X. 1998.The scientific expedition on modern lake evolution in the Qinghai-Tibet plateau: a preliminary report. *Journal of Lake Sciences*, 10: 95-96.

Yonghai, C., Jiancheng, L. & Weiping, J. 2005. Monitoring of water level variations of Hunlun lake with Tason-1 altimetric data. *Crustal Deformation and Earthquake*, 25: 11-16.

New Data of Family Apiaceae in the Khentii and Mongolia Daurian Phytogeographical Regions of Mongolia

Magsar Urgamal

Institute of Botany, Mongolian Academy of Sciences, Mongolia, urgamal@botany.mas.ac.mn

Abstract: In the paper included to new distribution data of the family Apiaceae species in the Khentei and Mongol Daurian phytogeographical regions of Mongolia are given. The since of Gubanov`s conspectus (1996) is newly added 2 species (*Angelica saxatilis, Bupleurum pusillum*) to the Mongolian flora and in total 6 species (*Angelica archangelica* subsp. *decurrens A. saxatilis, Bupleurum pusillum, Conioselinum longifolium, Heracleum sibiricum, Peucedanum falcaria*) new added in the Khentii and Mongol Daurian phytogeographical regions of the family Apiaceae of Mongolia.

Keywords: *New distribution, Apiaceae, phytogeographical region, Khentei and Mongol Daurian, Mongolia*

Introduction

The family Apiaceae which is one of the biggest families in the flora of Mongolia. At present time is family Apiaceae consists of 74 species and 37 genera, 5 subtribes belong to 12 tribes (4 clades) and 2 subfamilies heterogeneously distributed in the Mongolian flora. The included to 37 species and 19 genera distributed in the Khentei (2) and 31 species belong to 20 genera are distributed in the Mongol Daurian (4) phytogeographical regions of the family Apiaceae to the flora of Mongolia. (Urgamal, 2009). In this short communication, we present findings of new species of Apiaceae discovered in the Mongol Daurian region, Eastern Mongolia.

Materials and Methods

The family Apiaceae specimens from the Herbarium of the Institute of Botany, MAS (UBA), Herbarium of the National University of Mongolia (UBU), as well as additional data, were used for the present study. There are over 5 genera, 6 species and 28 specimens in total, which were collected by from the Khentei (2) and Mongol Daurian (4) phytogeographical regions (Figure 1).

Figure 1. Map of the phytogeographical regions of Mongolia (by Grubov, 1982)

Results

Currently according to reseach result we have officially new added registered for total 6 species from the Khentei (incl. 4 species and 4 genera) and Mongol Daurian (incl. 3 species and 3 genera) phytogeographical regions (Urgamal, 2013), family Apiaceae are included new distribution data (Table 1) the since of Gubanov`s conspectus (1996). Specimens cited have been collected by the first author, unless otherwise stated, and are deposited in her private herbarium; duplicate samples of most gatherings will be deposited.

Table 1. New distribution of family Apiaceae species in the Khentei and Mongol Daurian regions

Species	Specimens information	Specimens location
Khentei phytogeographical region (new added 4 species)		
1. *Bupleurum pusillum* Krylov	Khentii aimag, Tsenkhermandal sum, taiga and forest steppe. 1978.VIII.28. Collected by: Ch. Sanchir; Determined by: M. Urgamal.	N 48^{0}06`59`` E 109$^{0}$09`16``
2. *Conioselinum longifolium* Turcz.	Khentii aimag, Tsenkhermandal sum, Mukhar Gutain river, forest steppe. 1986.VIII.18. №00-279. Collected by: E. Ganbold, Determined by: M. Urgamal.	N 48^{0}05`34`` E 109$^{0}$12`17``
3. *Angelica saxatilis* Turcz. ex Ledeb.	Khentii aimag, Tsenkhermandal sum, taiga and forest steppe. 1978.VIII.28. Collected by: Ch. Sanchir; Determined by: M. Urgamal.	N 48^{0}06`59`` E 109$^{0}$09`16``
4. *Heracleum sibiricum* L.	Ulaanbaatar city, Bogdkhan mountain, Northern Zaisangiin am, forest steppe. 1998.VI.25. №98-18. Collected by: M. Urgamal, D. Magsar, U. Ligaa, Determined by: M. Urgamal.	N 48^{0}06`59`` E 106$^{0}$55`53``
Mongol Daurian phytogeographical region (new added 3 species)		
1. *Conioselinum longifolium* Turcz.	Khentii aimag, Tsenkhermandal sum, forest steppe. 1989.VIII.18. №00-280. Collected by: V.I.Grubov, Determined by: M.Urgamal.	N 47^{0}51`52`` E 108$^{0}$59`24``
2. *Angelica archangelica* subsp. decurrens (Ledeb.) Kuvaev	Tuv aimag, Batsumber sum, Narstiin denj, Udlugiin gol, with *Salix* forest steppe. ^{1}00-26-31 (109). 1976.VIII.19. Collected by: Ch. Sanchir; Determined by: M. Urgamal.	N 48^{0}24`13`` E 106$^{0}$47`21``
3. *Peucedanum falcaria* Turcz.	Selenge aimag, Bayangol sum, Kharaa river, forest steppe. 1974.VIII.23, №1745. Collected by: O.B. Jurba, Determined by: D. Magsar.	N 48^{0}54`15`` E 106$^{0}$05`57``

Discussion

In this short communication, we presented findings of 6 species belonging to 5 genera from the family of Apiaceae that were first time registered in the Khentii and Mongol Daurian phytogeographical regions, which are complimentary to the flora of Mongolia since of Gubanov`s conspectus (1996).

References

Gubanov, I.A. 1996. Conspectus of flora of Outer Mongolia (vascular plants). Moscow, Valang,: 77-79.

Urgamal, M. 2004. Key for determination of the family Celery Umbelliferae Juss. or Apiaceae Lindl. in Mongolia. Ulaanbaatar, "Jinst-Khargana" Press. 112p.

Urgamal, M. 2009. Flora of Mongolia. (Apiaceae-Cornaceae). volume. 10. Ulaanbaatar, "Bembi San" Press, 130p.

Urgamal, M. 2013. Brief conspectus of the family Apiaceae to the flora of Mongolia. *Proc. Inst. Bot., Mongolian Academy of Sciences*, 25: 38-47.

Urgamal, M., Oyuntsetseg, B. & Nyambayar, D. 2013. Synopsis and recent additions to the flora of Mongolia. *Proc. Inst. Bot., Mongolian Academy of Sciences*, 25: 53-72.

Dynamics of Riparian Vegetation of Steppe Lakes in the Dauria

Tkachuk Tatiana Evgenievna[1,2], Pazdnikova Nelli Mikhailovna[1], Kozlova Victoria Nikolaevna[2], Saraeva Lyudmila Ivanovna[1], Goryunova Svetlana Valerievna[3]

[1]*Daursky State Nature Biosphere Reserve, Nizhny Tsasuchey, Babushkin str., 129, Chita, Zabaikalskykrai, Russia,* tetkachuk@yandex.ru
[2]*Transbaikal State University, Chita, Russia*
[3]*Institute of Genetics of Russian Academy of Science, Moscow, Russia*

Abstract: Vegetation is the key component of ecosystems and an indicator of environmental processes, so, its monitoring is important for ecosystem science, natural resource protection and management. Steppe-lake nature complexes play an important role in the maintenance of biodiversity and its dynamics. One of the important, unique aspects of the climate of the Dauria is the cyclic humidification that causes fluctuations inthe terrestrial ecosystems of the lakes. Currently a 30-year period of draught period is in its final stages. Vegetation dynamics at three lakes of different size, morphology and long-term hydrological dynamics are considered in this article: Nizhny Mukey, Zun-Torey and Huh-Nur. It was revealed that the dynamics and spatial structure of the riparian vegetation mostly depends on water retreatment rate. Slow retreatment is characterized by typical riparian vegetation series shifting towards the water line. More rapid water retreat involves as shift of vegetation series, a significant redistribution of meadow and pioneer vegetation areas and changes in community species lists. When large areas dry at the same time, a heterogeneous vegetation pattern is formed. Succession entails patches fusion and a decline in diversity. Vegetation closest to water is the most dynamic and undergoes deep successional changes. Steppe communities change slightly, mostly due to fluctuation in the abundance of predominating species.

Keywords*: Dauria, vegetation, steppe, coastal vegetation, succession, climate changes.*

Introduction

The Dauria International Protected Area is situated in the steppe zone and plays an important role in nature conservation of the transboundary Daurian region, which covers parts of Russia, Mongolia and China. The most common plant communities of zonal steppe environment in the region are *Stipa krylovii* steppe, *Stipa krylovii-Leymus chinensis-Cleistogenes squarrosa* steppe, polidominant small-tuft (*Agropyron cristatum, Koeleria cristata, Cleistogenes squarrosa, Poa argunensis, Festuca lenensis, F. litvinovii*) steppe, grass-forb (*Stipa krylovii, Leymus chinensis, Cleistogenes squarrosa, Serratula centauroides, Artemisia frigida, Haplophyllum dauricum, Allium polyrhizum, Allium bidentatum*) steppe distributed on chestnut soils. Brackish and saline lakes of different size are very characteristic for this arid region with plane and rolling relief (Atlas of Transbaikalia, 1967). The biggest lakes include Dalai Lake, the Torey Lakes, the Buir Nur and the Huh Nur. One of the important characteristics of the climate of the Dauria is its cyclical nature which includes long cycles of different precipitation levels, and different durations. The most pronounced is the 30-years cycles of humidification which cause fluctuations in hydrological regimes of lakes and changes in water and terrestrial ecosystems (Badmaeva et al. 2010; Kirilyuk at al. 2011; Obyazov, 1994; Tkachenko & Obyazov, 2003; Tkachuk, 2012). Some lakesbecome shallow during the drought stage of the cycle, while others completely disappear. Lake-steppe natural complexes are crucial for sustaining wildlife and at the same time reflect the climate changes with their water level and condition of vegetation (Goroshko, 2011; Kirilyuk at al. 2011; Soda lakes, 1991; Zhao et al. 2011). Climate-dependent changes to lakes and surrounding vegetation differ at lakes of different size and feed types. There is no direct relationship between size and drying-up ratio. For example, during the last drought phase (began in 1999) the Barun-Torey Lake, with a water area of 560 sq. km, was completely dry by 2009.A smaller lake, Lake Nizhny Mukey, 8 km west of Barun-Torey, with a water area of about 1 sq.km, was reduced by 50% during the drought period. Under conditions of cyclical climate and changing area of water bodies vegetation of the region must undergo changes as well.

Monitoring of ecosystems is one of the priority tasks for the Dauria International Protected Area as for environmental protection and scientific institutions. Nowadays the Dauria is going through a period of draught, as a part of the 30-year climate cycle. It is important to understand the natural processes, and to observe and record changes in ecosystems during this time. Vegetation is a very good indicator of all environmental conditions and processes, and at the same time is a key component of ecosystem. Therefore, vegetation monitoring is important for both ecosystem science, nature protection, and management. Here we consider examples of vegetation dynamics at three lakes with different morphology and characteristics of long-term hydrological regime dynamics.

Materials and Methods

In 2008-2011 on the territory of Russian and Mongolian parts of Dauria we set up a system of monitoring transects along the riparian zone of nearly 90 steppe lakes of different size and morphology, with different soils, to study plant community spatial pattern, composition and diversity. Each transect is perpendicular to the shoreline, so it crosses a range of riparian vegetation of vegetation including plant communities from pioneer to climax and belonging to three vegetation types: steppe, meadow and pioneer vegetation. These transects were surveyed at different time intervals (one year, two-three years, 5-6 years). Along each transect we undertook standard geobotanical sampling at each plant community and marked communities margins with GPS. This allowed the use of GIS for measuring distances, and spatial pattern analysis.

Results and Discussion

The Nizhny Mukey Lake is situated on the very south of Eastern Transbaikalia very close to Russian-Mongolian border, 8 km west of Barun-Torey Lake. It is a part of Daursky Nature biosphere Reserve. The location of the lake is characterized by rolling relief and dominating of forbs steppe vegetation. Now the lake has rounded shape 1000 m length and 700 m width. The lake depression has sharp slopes on north-east and south. Water is highly salted with pH 9,3. The monitoring transect was set in 2010 at north-west shore. The transect length in 2010 was 163 m; in 2013 it became 193 m (Figure 1). The transect at Nizhny Mukey Lake crossed several plant communities: *Leymus chinensis* L. steppe, *Phragmites australis* (Gav.) Trin.ex Steudel – *Leymus chinensis* meadow, *Phragmites australis* meadow, *Phragmites australis – Eleocharis palustris* (L.) Roemer et Schultes meadow, *Eleocharis palustris* meadow, *Eleocharis palustris Puccinellia macranthera* Krecz. meadow, *Puccinellia macranthera-Eleocharis palustris* meadow, *Puccinellia macranthera* meadow, *Puccinellia macranthera-Suaeda corniculata* (C.A. Meyer) Bunge s. str. meadow, *Suaeda corniculata-Puccinellia macranthera* meadow and *Suaeda corniculata* pioneer community. *Tripolium vulgare* Nees, *Triglochin maritimum* L., *Triglochin palustre* L. and others are also constant species for meadows and can sometimes reach high abundances. According to dominant species we divided the series at N. Mukey lake into several belts (Figure 1). The shore was cleared from water in the 30 m belt, with the highest speed in 2012 year. During four years of the monitoring the width of *Phragmites australis– Leymus chinensis* and *Eleocharis palustris* belts, the length stayed practically constant. In *Eleocharis* community alteration of subdominant species was observed. *Puccinellia macranthera-Eleocharis palustris* meadow during three years remained of stable width and species composition, but in 2013 its width grew by 10 m through redistribution of species abundance: *Eleocharis palustris* abundance had decreased while *Puccinellia macranthera* increased. So, the most dynamic are plant communities nearest to water. The width of *Suaeda corniculata* community increased by 24 meters in four years.

In 2012-2013 despite increasing precipitation, a continued decrease in water area was observed. During the first year after reduction in lake area, the lake shore was colonized by annual halophytic species such as *Suaeda corniculata* (C.A. Meyer) Bunge, subsequently their abundance increases, than perennial halophyte species (*Puccinellia macranthera, Tripolium vulgare*) appear.

Generally vegetation dynamics at the Nizhny Mukey Lake shore can be characterized as simple shift of entire series towards the water line and some extension of vegetation belts with no changes in their list. The most active dynamic is observed in vegetation belts closest to the water due to the loss of lake area and formation of new terrestrial habitats where lake water once was.

Lakes Zun-Torey and Barun-Torey belong to biggest lakes in the region and have water area 300 km² and 560 km², maximum depth 7 m and 4,5 m respectively. Both lakes have gently sloping shores, sludgy at Barun-Torey and with various texture at Zun-Torey: north-west, east and south shores are mostly sandy, sometimes sludgy; northern and south-west shores are stony, with rock outcrops. Every year of dry climate stage tens to hundreds meters of shore become exposed, and rate of this process is changing depending on the water source feeding the lake and the bottom relief.

The monitoring transect 1050 meters long was set at the western shore of Zun-Torey Lake in 2009 from steppe to water line The transect along the shore of Zun-Torey Lake (2009) crossed 16 plant communities and pioneer plant groupings. Pioneer vegetation in 2009 took up 450 m of the transect, and was diverse, including the following communities and groupings: *Suaeda corniculata-Kochia densiflora-Tripolium vulgare; Nitraria sibirica; Suaeda corniculata-Kochia densiflora; Kochia densiflora-Puccinellia tenuiflora; Puccinellia tenuiflora-Kochia densiflora;* three communities dominated by *Suaeda corniculata;* polydominant pioneer grouping (*Suaeda corniculata, Chenopodium glauca, Atriplex sibirica*).

In 2013 the belt of pioneer vegetation shifted towards the water up to 535 m. Its diversity decreased and was represented by only two communities *Suaeda corniculata-Puccinellia tenuiflora* and *Puccinellia tenuiflora-Kochia densiflora*.

Growth of the meadows belt was faster than water line retreat in the period 2009-2013 and lots of pioneer grouping of 2009 were replaced by meadows by 2013. The meadows belt has grown from 540 m to 755 m. The number of communities changed by 2013 from 8 to 9 but they became much more extended than in 2009. So vegetation diversity per area unit has declined (Figure 2). Steppe-meadow border has shifted insignificantly. Communities dominated with *Artemisia frigida* transformed into *Stipa krylovii* steppes.

By 2013 the total length of transect at western shore of Zun-Torey Lake extended by 535 meters and reached 1584 m. In the same time the number of communities crossed by this transect decreased from 16 to 13. Thus, the general direction of the development of the vegetation series here is the merging of neighboring communities by increasing the abundance of common dominant species. This leads to a decrease in the vegetation diversity in course of succession, as shoreline retreat was slower than the succession of vegetation.

Very similar changes are observed at North-East shore of Zun-Torey lake where monitoring transect was set in 2010. In the period 2010-2013 its length grew from 217 to 350 m, i.e. half as much again, like at western shore. At the north-east shore the pioneer vegetation belt extended from 30 m in 2010 when it was represented by only *Suaeda corniculata* grouping, up to 95 m in 2013. In the place of former *Suaeda corniculata* grouping *Carex reptabunda-Puccinellia tenuiflora* meadow was formed; the *Suaeda* belt shift amounted 190 m due to water line retreat.

Meadow vegetation in 2010 occupied 128 m and was represented by the following communities: *Carex reptabunda-Puccinellia tenuiflora; Puccinellia tenuiflora-Carex reptabunda; Tournefortia rosmarinifolia-Polygonum sibiricum; Tournefortia rosmarinifolia; Carex reptabunda-Phragmites australis; Phragmites australis-Leymu schinensis.* In 2013 meadows shifted by 95 m replacing pioneer vegetation and reached 200 m width; its diversity decreased from 6 to 3 communities: *Carex reptabunda-Puccinellia tenuiflora-Suaeda corniculata; Puccinellia tenuiflora; Puccinellia tenuiflora-Carex reptabunda-Phragmites australis.*

The *Phragmites australis-Leymus chinensis* meadow was replaced by *Leymus chinensis-Koeleria cristata* steppe. As a result the steppe-meadow boundary shifted by 23 m. In forbs steppe community (2009) dominant species had altered and it appeared in 2013 as a *Stipa krylovii* steppe. Thus, more rapid retreat of water at Zun-Torey lake compared with a small-sized and relatively more stable Nizhny Mukey lake entails not only displacement of vegetation series towards retreating water but drives significant redistribution of areas of meadow and pioneer vegetation with change in communities and with trend of reducing of this set. Steppe vegetation changes slightly; the main feature of its change is fluctuations in dominate species, which we described previously (Tkachuk & Zhukova, 2013).

In some cases loss of water area and exposure of the lake bottom occurs rapidly across large areas. Vegetation dynamics in such cases have specific features. For example, changes of the sort we observed at the western shore of Huh-Nur Lake in Mongolia at the location of a shallow bay. This bay had dried almost completely during one season. The bay bottom is flat with saline sludgy soil. A monitoring transect 3380 m length was set here in 2010. It began in site of *Stipa krylovii-Artemisia frigida* steppe and crossed *Leymus chinensis* steppe and 17 meadow and pioneer communities formed in place of the bay. *Leymus chinensis-Carex reptabunda-Chenopodium glaucum, Kochia densiflora-Leymus chinensis, Kochia densiflora-Polygonum sibiricum, Suaeda corniculata-Tournefortia rosmarinifolia-Polygonum sibiricum, Sonchus arvensis* meadows etc. there were among them. Almost all areas crossed by a transect had vegetation with pattern structure. Species composition and dominance in separate vegetation spots were determined on the one hand by micro relief, on the other hand by random character of colonization of the territory and formation of a variegated patchwork of plots dominated with different species at the beginning of ecological succession.

Nearest to water line were two communities dominated with Chenopodiaceae species: *Suaeda corniculata-Atriplex sibirica* and *Kochia densiflora-Suaeda corniculata* meadows. In 2013 forbs-*Chloris virgata* and *Carex reptabunda-Saussurea amara-Artemisia sieversiana* communities were formed in their place. By 2013 the transect was extended by 880 m. This area dried between 2010 and 2013.In 2013 we found nine belts of vegetation in different stages of succession: *Leymus chinensis-Carex reptabunda*; *Kochia densiflora-Suaeda corniculata-Chenopodium glaucum; Suaeda corniculata- Kochia densiflora; Kochia densiflora-Chenopodium glaucum; Nitraria sibirica-Chenopodium glaucum; Suaeda corniculata; Chenopodium glaucum-Suaeda corniculata-Atriplex sibirica; Nitraria sibirica* (juveniles)-*Chenopodium glaucum-Suaeda corniculata; Nitraria sibirica* (seedlings and stubs).

It is notable that on the dried shore in last year there were not only young plants of *Nitraria sibirica* but also old stubs of dead individuals of this shrub which grew here during previous dry stage. The rest of transect kept pattern structure though successional changes aspect of all patches and in many cases species composition altered significantly. Dominant species in all these communities declined.

The vegetation dynamics at the former bay of Huh-Nur Lake can be described as a combination of two processes. The first is succession of a heterogonous complex of vegetation formed immediately after drying of a large area, leading to the merging of vegetation types, and reduced diversity. The second is typical for all drying lakes forming riparian vegetation communities consisting of belts of different stages of succession and consequent shifts towards the water line.

Conclusion

Dynamics and space structure of coastal vegetation depends first of all on the rate of water retreatment. In the case of slow retreat classical vegetation communities including several belts in different successional stages are formed. The vegetation dynamics can be characterized as a simple shift of entire communities towards the water line and some extension of vegetation belts with no changes in their species lists.

More rapid retreat of water entails not only displacement of vegetation types towards retreating water but drives significant redistribution of areas of meadow and pioneer vegetation with changes in communities and with trends of decreasing number. When a large area is drying at once pattern of heterogeneous vegetation patches is formed. Their succession entails a merging of vegetation types and reduced diversity.

The most active dynamics are observed in vegetation closest to water due to exposure of the lake bottom and formation of new terrestrial habitats. Steppe vegetation changes slightly; the main feature of its change is fluctuations in dominant species abundance.

References

Atlas of Transbaikalia (1967). Moscow-Irkutsk. 176 p.

Badmaeva, N.K., Sandanov, D.V. & Tkachuk, T.E. 2010. Halophytic ecosystems in the arid zone of Transbaikalia becoming dryer: evidences from C-4 plants invasion // Ecological consequences of biosphere processes in the ecotone zone of Southern Siberia and Central Asia: Proceedings of the International Conference. Vol. 1. Oral repots. Ulaanbaatar (Mongolia), September 6–8, 2010. — Ulaanbaatar: Bembi san Publishing House. p. 136-139

Goroshko, O.A. 2011. Analysis of the state and multi-year dynamics of waterfowl in Zabaikalskykrai and recommendations for organizing their rational use. Report of the scientific research. State Biosphere Reserve Daursky. 19 p.

Obyazov, V.A. 1994. Connection of fluctuations in water fill of the Transbaikalia steppe zone lakes with multi-year hydro-meteorological changes on the example of the Torey lakes. News of the Russian Geographic Society 126, 48-54.

Soda lakes of Transbaikalia: ecology and productivity. 1991.L.I.Lokot', T.A. Strizhova, E.P. Gorlacheva et al. Novosibirsk. 216 p.

Tkachenko, E.E. & Obyazov, V.A. 2003. Change of the Torey lakes level and nesting of colonial near-water birds. Ground vertebrates of Dauria. Collection of scientific papers of the Daursky State nature biosphere reserve. Chita. 3: 44-59.

Tkachuk, T.E. 2012. Multi-year vegetation dynamics of Daursky Nature Reserve according to remote-sensing data. *Proceedings of Samara Scientific Center of Russian Academy of Science*. 14: 1391-1394

Tkachuk, T.E. & Zhukova, O.V. 2013. Vegetation Dynamics in Daursky Nature Reserve. Scientific proceedings of Transbaikal State University of Pedagogics and Humanities. 48: 46-57

Kirilyuk, V.E., Obyazov, V.A., Tkachuk, T.E. & Kirilyuk, O.K. 2011. Influence of climate change on wildlife in the Daurian ecoregion. Eurasian Steppes - Ecological Problems and Livelihoods in a Changing World" edited by Marinus J.A. Werger&Marja A. Van Staalduinen. Published by Springer, (Dordrecht, Berlin, Tokyo, Boston, London) P.400-470

Zhao, F., Liu, H., Yin, Y., Hu, G. & Wu, X. 2011. Vegetation succession prevents dry lake beds from becoming dust sources in the semi-arid steppe region of China. Earth Surface Processes and Landforms 36: n/a. doi: 10.1002/esp.2114

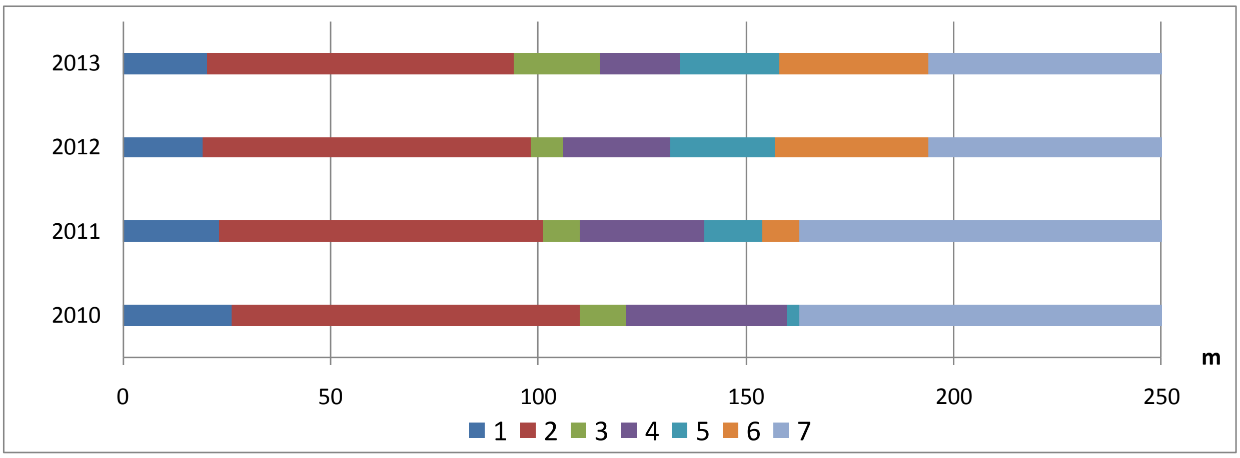


Figure 1. Changes of coastal vegetation of the Nizhny Mukey Lake (**Legend**: **Meadows**: 1 - *Phragmites australis– Leymus chinensis, 2 - Eleocharis palustris, 3 - Eleocharis palustris−Puccinellia macranthera,* 4 - *Puccinellia macranthera−Eleocharis palustris,* 5 - *Suaeda corniculata,* 6 - no vegetation, 7 -water)

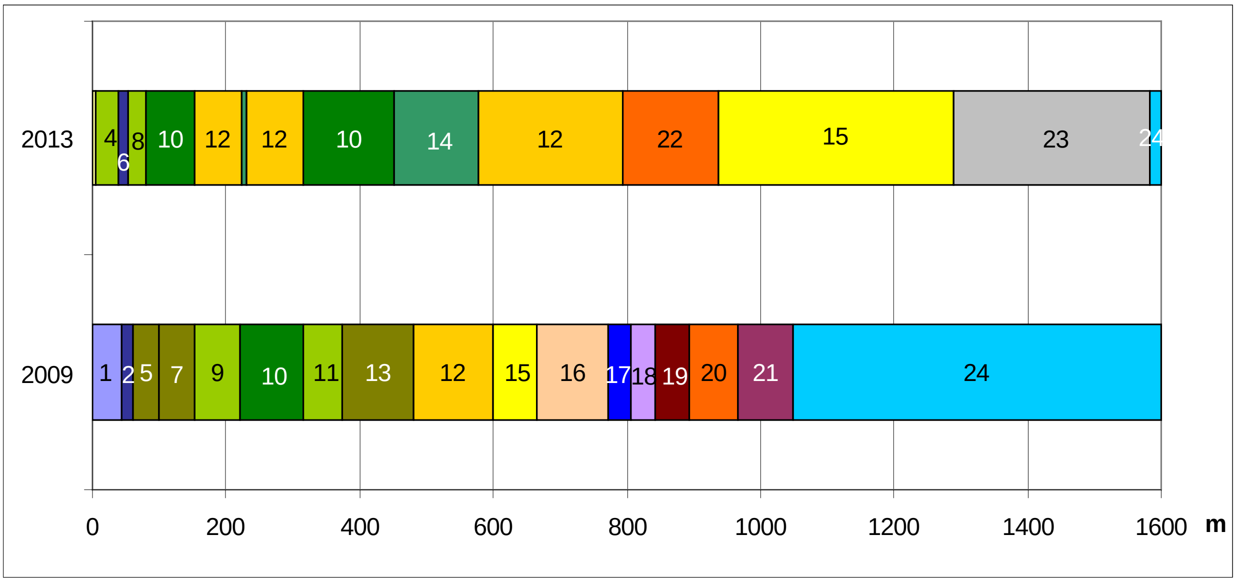


Figure 2. Vegetation dynamics at the western shore of Zun-Torey Lake (**Legend**: **Steppe communities**; 1- *Artemisia frigida*, 2 - *Artemisia frigida* – grass, 3 - *Stipa krylovii, 4 - Stipa krylovii* – forbs; **Meadow communities**: 5 - *Phragmites australis – Leymus chinensis – Hordeum brevisubulatum*, 6 - *Phragmites australis – Leymus chinensis, 7 - Puccinelliatenuiflora – Phragmites australis, 8- Phragmites australis* – forbs, 9 - *Puccinellia tenuiflora–Phragmites australis –Kochia densiflora,* 10 - *Phragmites australis*, 11- *Puccinellia tenuiflora–Phragmites australis –Tournefortia rosmarinifolia*, 12- *Puccinellia tenuiflora,* 13 - *Phragmites australis –Tournefortia rosmarinifolia–Carex reptabunda,* 14 - *Phragmites australis –Carex reptabunda*–forbs, 15 - *Puccinellia tenuiflora–Kochia densiflora*, 16 - *Kochia densiflora–Puccinellia tenuiflora*; **Pioneer vegetation**: 17 - *Suaeda corniculata – Kochia densiflora–Tripolium vulgare*, 18 - *Suaeda corniculata–Kochia densiflora,* 19 - *Nitraria sibirica*, 20 - *Puccinellia tenuiflora–Chenopodium glaucum, 21 - Suaeda corniculata*, 22 - *Forbs - Tournefortia rosmarinifolia*, 23 - no vegetation, 24 - water).

-

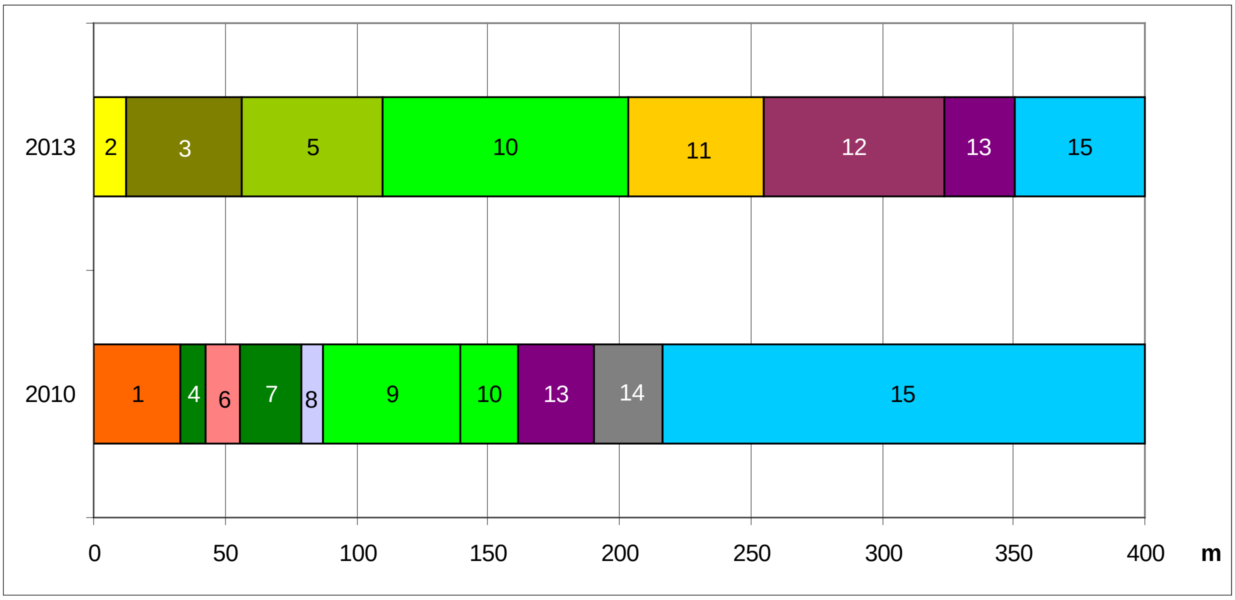


Figure 3. Vegetation dynamics at North-East shore of Zun-Torey Lake **(Legend: Steppe communities**: 1 - Forbs steppe, 2 - *Stipa krylovii*, 3 - *Leymus chinensis – Koeleria cristata*; **Meadow communities**: 4 - *Phragmites australis – leymus chinensis*, 5 - *Puccinellia tenuiflora–Carex reptabunda–Phragmites australis*, 6 - *Tournefortia rosmarinifolia*, 7- *Carex reptabunda–Phragmites australis, 8 - Tournefortia rosmarinifolia–Polygonum sibiricum,* 9 - *Puccinellia tenuiflora - Carex reptabunda,* 10 - *Carex reptabunda–Puccinellia tenuiflora,* 11 - *Puccinellia tenuiflora*; **Pioneer vegetation:** 12 - *Suaeda corniculata–Puccinellia tenuiflora,* 13 - *Suaeda corniculata*, 14 - no vegetation, 15 - water).

Effect of Climate Change on the *Stipa Krylovii* Grassland Vegetation of Hulun Buir

Wu Liji[1], *Li Guo-hai*[1], *Zhang Na*[1], *Li Xiao-rong*[2], *Cui Hai-qing*[3]

[1]*Da Lai Lake National Nature Reserve Inner Mongolia, Hulun Buir, Inner Mongolia 021008, China*
[2] *Xinbaerhuyou qi Meteorological Bureau, Hulun Buir, Inner Mongolia 021300, China*
[3] *Ningcheng Country Water Conservancy Bureau, Chifeng, Inner Mongolia 024200, China*

Abstract: In order to understand the effect of climate change on *Stipa krylovii* grassland flora and its characteristics, we investigated the temperature and vegetation of Hulun Buir *Stipa krylovii* grassland in Argun River Basin during 2002—2006. Results showed that the average temperature of this area is declining over time. The importance value of *Stipa krylovii, Leymus chinensis, Suaeda glauca, Potentilla bifurca* decreased with the yearly decrease in winter maximum temperature, whereas that of *Cleistogenes aquarrosa* increased. The vegetation height, cluster number, coverage and important value of *Cleistogenes aquarrosa* was significantly negatively correlated with the maximum winter temperature. The effect of precipitation on the dominant species was not obvious. There was no significant relationship between winter maximum temperature, diversity indices (Simpson index and Shannon _wiener index) and evenness index. Therefore, temperature was no significant impact on the structure and function of *Stipa krylovii* grassland community during these five years, although a few plants were sensitive to the change in winter maximum temperature.

Key words: *Stipa Krylovii grassland; Climate change; important value; Characteristics of grassland*

Introduction

Flora is an important aspect of natural ecological systems; it can indicate changes in some elements of the natural environment and changes in landscape ecology (Liu, Fan & Wu, 2009). Vegetation response to climate change has become a hot topic for researchers (Zhang, Ge & Zheng, 2005). Temperature is one of the key factors that control the distribution and growth of vegetation, its changes will affect the structure and function of natural environments (Wang & Zhou, 2004). Some scholars believe that global warming will cause an increase in vegetation productivity, soil respiration and an increase in C_4 plant richness (Jekison & Admas, 1991; Krankina & Dixon, 1997; White & Campbell, 2001). Vegetation is not only affected by temperature but also by precipitation (Yang, Zhao & Na, 2010). Single or multiple factors can cause change in vegetation to different degrees, (Zhou & Zhang, 1997; Fang, 2001), however some researchers believe that precipitation will affect type and coverage of vegetation (Jian, 2011). Current research on grassland ecosystem responses to climate mainly focus' on remote sensing vegetation index's (Li, 2006) and community diversity index's (Wang, 2004). Some research has been undertaken on an important value and a growth of Hulun Buir grassland vegetation. Current research on plant responses to temperature mainly focuses on average temperature. Therefore there is almost no research on responses to maximum temperature, minimum temperature and average temperature.

Stipa krylovii Roshev grassland is unique to central Asia, but also the most widespread grassland in the region. According to Inner Mongolia and Ning Xia expedition teams from the Chinese Academy of Sciences (1985), Hulun Buir *Stipa krylovii* Roshev grassland is not only the most common Chinese temperate grassland system, and is also an important ecological protective barrier in northern China (Luo, Wu & Zhang, 2011). *Stipa krylovii* Roshev grassland is also an important vegetation resource in the Hulun Buir area; it plays an important role in livestock production. Arid climate and fragile ecosystems are sensitive to climate change, consequently Hulun Buir *Stipa krylovii* Roshev grassland shares characteristics with regions typically used in globalization studies (Yuan, 2007). This study uses the Hulun Buir *Stipa krylovii* Roshev grassland as research system, using meteorological and vegetation data from 5 consecutive years from 2002-2006, we analyze annual temperature change, and the effect of climate change on plant height, tuft number, important value and quantitative characteristics of grassland communities of *Stipa krylovii* Roshev most common species. This paper explores the response mechanism of grassland plants to climate change, to provide a theoretical basis for the prediction of trends in grassland flora with climate change.

Materials and methods

Study area

The study area is located in Hulun Lake, also known as Dalai Lake, and the surrounding Hulun Buir plateau hinterland, in the northeastern Inner Mongolia Plateau. With a north latitude of 48°17′~48°56′, longitude of 117°06′~117°35′, and altitude of 574 m, this area belongs to the upstream low hills landform of Argun River basin. These permanent plots were located on the top of low mountains and hills, which located the east of spring which located the north of WuLannuoer. The climate of this area is a semi-arid continental monsoon climate, characterized by a long cold winter and a dry windy spring, drastic fall temperature decrease, early frost, with precipitation mainly concentrated in June—September, and a sandy chestnut soil. The main vegetation type is *Stipa krylovii* Roshev grassland, and the dominant species are *Stipa krylovii* and *Leymus chinensis.*

Research method

We surveyed fixed fenced plots in *Stipa krylovii* Roshev grassland between 2002—2006, recording meteorological and vegetation data between July and August of each year. It had slightly inclined terrain, smooth surface, soil type is sandy chestnut soil, and there five sites for monitoring of sample by five times. In each plot we surveyed 10 vegetation quadrats of 1×1 m. In each quadrat we recorded the plant species present, plant height, tuft number, and importance value. Meteorological data was obtained from the Hulun Buir Meteorological Bureau. To understand the variation in *Stipa krylovii* Roshev grassland temperature with time, regression analysis was used to analyze the relationship between time and average temperature, maximum temperature, and minimum temperature, for the period 2002—2006.

Analysis data

We calculated the importance value for each species present in the plots, using the following formula:

Important value= (Relative density + relative frequency + relative biomass)/3

We calculated the Shannon-Winener (*H*), and Simpson (*D*) diversity indexes, and an evenness index (C), which indicate characteristics of the vegetation community. In this study, we use important value to calculate.

$$H=-\sum P_i lnP$$

$$D=1/\sum P_i^2$$

In the calculation, P_i is the ration of the *i*-th individual species (biomass, important value etc) to its plots total individual numbers (biomass, important value).

$$C=H/lnS$$

Where, *S* is the number of species, and *H* is the Shannon-Winener index.

SAS 9.0 and Excel software were used to analyze the data and undertake the regression analysis. As a correlation test at 0.05 level, the calculation is used the least significant difference method (LSD) to analysis interannual climate data, significance test at 0.05 level.

Results

The characteristics of temperature interannual variation

Table 1 shows the fluctuating decline in average temperature, maximum temperature, and minimum temperature in whole year in the study area. Annual average temperature decreased 0.1^{0}C; there was a significant correlation between minimum temperature, winter average temperature, winter maximum temperature and year (P < 0.05). Winter average temperature decreased 1.45^{0}C. There was no significant correlation between years and average temperature, maximum temperature, minimum temperature of seasons, particularly, summer and winter. Annual minimum temperature decreased, winter maximum temperature and winter average temperature increased in 2006. So there was no obvious relationship between the decrease of annual minimum temperature and the decrease of winter temperature.

Table 1 Regressive analyses between time and average temperature, maximum temperature and minimum temperature

Time	Simple linear regression	Coefficient square(R^2)	Significance P
Annual average temperature	T_{ave-a}=2.2233-0.1year	0.1256	0.5543
Winter half the average temperature	T_{ave-wh}=-10.512-0.195year	0.6598	0.0948
Summer half the average temperature	T_{ave-sh}=16.002-0.145year	0.1218	0.5672
Spring average temperature	T_{ave-sp}=4.680-0.54year	0.4174	0.2395
Summer average temperature	T_{ave-su}=21.22+0.013year	0.0003	0.9798
Fall average temperature	T_{ave-f}=-0.47+0.683year	0.6549	0.0968
Winter average temperature	T_{ave-w}=-16.537-0.737year	0.7899	0.0262*
Annual maximum temperature	T_{max-a}=23.32-0.2year	0.1414	0.6834
Spring maximum temperature	T_{max-sp}=13.6-0.32year	0.122	0.5645
Summer maximum temperature	T_{max-su}=23.32-0.2year	0.1414	0.5327
Fall maximum temperature	T_{max-f}=12.49+0.25year	0.4837	0.1922
Winter maximum temperature	T_{max-w}=-12.07-1.45year	0.8153	0.0358*
Annual minimum temperature	T_{min-a}=-16.6-1.16year	0.8343	0.0302*
Spring minimum temperature	T_{min-sp}=-5.82-0.46year	0.0771	0.651
Summer minimum temperature	T_{min-su}=19.76-0.04year	0.002	0.9429
Fall minimum temperature	T_{min-f}=-13.99+1.37year	0.643	0.1026
Winter minimum temperature	T_{min-w}=-20.49-0.17year	0.0957	0.6125

*Note: *: P<0.05, **:P<0.01(the same as below,)*

Table 2 shows the variance analysis of average temperature, maximum temperature and minimum temperature of different period. This shows that average annual temperature declined in a fluctuating manner, and the average temperature in 2006 was significantly lower than the other four years. Minimum temperature showed a decreasing trend, with time, winter average temperature decreased, and winter average temperature in 2006 was significantly lower than that of 2002 (P<0.05). With the interannual change, winter maximum temperature gradually, and there was significant difference among each year in winter maximum temperature; but there was no significant difference among each year in winter minimum temperature.

Table 2. Variance analysis of average temperature, maximum temperature and minimum temperature of different period

Time	2002	2003	2004	2005	2006
Annual average temperature	2.37^{a}	1.38^{c}	2.33^{a}	1.99^{ab}	1.56^{bc}
Annual minimum temperature	-16.8^{a}	-20.2^{b}	-20.2^{b}	-21b	-22.2^{bc}
Annual maximum temperature	23.1^{a}	22.2^{ab}	23.4^{a}	23.4^{a}	21.5^{b}
Winter half the average temperature	-10.67^{a}	-11.15^{ab}	-10.75^{a}	-11.40^{ab}	-11.52^{ab}
Summer half the average temperature	16.13^{a}	14.85^{b}	16.03^{a}	15.97^{a}	14.85^{b}
Spring average temperature	5.40^{a}	2.50^{b}	2.17^{b}	2.57^{b}	2.67^{b}
Summer average temperature	21.47^{ab}	19.77^{c}	22.53^{a}	22.23^{a}	20.30^{bc}
Fall average temperature	-0.30^{d}	1.07^{c}	3.50^{a}	3.57^{a}	2.77^{b}
Winter average temperature	-17.10^{a}	-17.83^{ab}	-18.90^{b}	-20.40^{c}	-19.50^{bc}
Spring maximum temperature	14.9^{a}	11.7^{c}	11.6^{c}	11.7^{c}	13.3^{b}
Spring minimum temperature	-3.1^{a}	-9.9^{e}	-8.9^{d}	-7.5^{c}	-6.6^{b}
Summer maximum temperature	23.1^{a}	22.2^{b}	23.4^{a}	23.4^{a}	21.5^{bc}
Summer minimum temperature	20.1^{a}	17.9^{c}	20.9^{a}	20.9^{a}	18.4^{b}
Fall maximum temperature	13.1^{a}	12.4^{b}	13.2^{a}	13.9^{a}	13.6^{a}
Fall minimum temperature	-13.4^{d}	-12.1^{c}	-7.4^{a}	-7.8^{a}	-8.7^{b}
Winter maximum temperature	-12.9^{a}	-15.4^{b}	-16.2^{bc}	-19.5^{d}	-18.1^{cd}
Winter minimum temperature	-21.6^{a}	-20.2^{a}	-20.3^{a}	-20.7^{a}	-22.2^{a}

Note: Different small letters mean significant differences at the 0.05 level, different capital letters mean significant differences at the 0.01 level, the same as below

The effect of the decrease of winter maximum temperature on dominant species

The sum of annual importance value of these nine most common species accounted for 78 percentage of the whole community. As can be seen from Table 3, *Stipa krylovii* regins supreme on the predominant species, its important value accounted for 37.98 percent of the sum of important value of other most common species, according to the annual important value from large to small. Most common species respectively are *Stipa krylovii, Leymus chinensis,Allium polyrhizum, Artemisia anethifolia, Reaumuria soongorica, Suaeda salsa, Potentilla bifurca, Atriplex sibirica,Cleistogenes squarrosa.* Nine most commonmost species fluctuant change in different year, *Stipa krylovii*, *Leymus chinensis*, *Potentilla bifurca*, *Suaeda salsa* showed a fluctuating decreasing trend, until 2006, compared with 2002. The important values of *Stipa krylovii* and *Leymus chinensis* decreased 9.17 and 8.49% respectively.

Table 3 Changes of most common species' important values in *Stipa krylovii* grassland

Species	Year					Mean ± SE
	2002	2003	2004	2005	2006	
Stipa krylovii	32.28	28.19	31.27	30.12	29.32	30.24 ±1.60
Leymus chinensis	20.14	14.33	18.73	17.42	18.43	17.81 ±2.17
Allium polyrhizum	12.64	13.07	14.02	14.04	13.42	13.44 ±0.61
Potentilla bifurca	1.92	1.50	1.67	2.03	1.78	1.78 ±0.21
Artemisia anethifolia	4.04	6.84	5.67	4.74	5.02	5.26 ±1.06
Reaumuria soongorica	4.37	5.12	4.78	5.01	4.79	4.81 ±0.29
Atriplex sibirica	0.82	1.03	1.08	1.32	0.94	1.03 ±0.12
Suaeda salsa	4.62	5.14	3.78	4.12	4.04	4.34 ±0.54
Cleistogenes squarrosa	0.66	0.88	1.03	1.21	0.93	0.92 ±0.23

In order to understand whether these nine most common species were affected by winter maximum temperature, Spearman analysis method was used to do a correlation relationship between the change of winter maximum temperature and the important value, plant height, tuft number of nine most common species. Table 4 shows the negative correlation between the winter maximum temperature and plant height, tuft number, important value of *Cleistogenes squarrosa* (*P*□0.05). There was a negative correlation between the winter maximum temperature and tuft number of *Atriplex sibirica*; there was no significant correlation between winter maximum temperature and the characteristics of other species. Therefore, the decrease in winter maximum temperature affects several most common species, but does not affect dominant species, or the structure of S*tipa krylovii* Roshev grassland.

Table 4 Coefficient relationship between most commonmost common species' height, cluster number, important value and winter maximum temperature

Species	Height and winter maximum temperature		Cluster number and winter maximum temperature		Important value and winter maximum temperature	
	Correlation coefficient	Significant level	Correlation coefficient	Significant level	Correlation coefficient	Significant level
Stipa krylovii	-0.7325	0.1592	-0.2869	0.6398	0.4440	0.4538
Leymus chinensis	-0.1009	0.8718	-0.1273	0.8383	0.2270	0.7135
Allium polyrhizum	0.7331	0.1587	-0.4257	0.4748	-0.7916	0.1105
Potentilla bifurca	0.3754	0.5335	-0.4895	0.4026	-0.2782	0.6504
Artemisia anethifolia	0.4687	0.4259	0.7750	0.1237	-0.0547	0.9304
Reaumuria soongorica	-0.0367	0.9533	0.8112	0.0957	-0.6236	0.2610
Atriplex sibirica	-0.5204	0.3686	-0.9437*	0.0159	-0.7780	0.1213
Suaeda salsa	-0.0735	0.9066	-0.2143	0.7293	0.5206	0.3685
Cleistogenes squarrosa	-0.8901*	0.0421	-0.8897*	0.0432	-0.8981*	0.0384

The growth of plants was not only affected by temperature but also by precipitation. This experimental plot enclosed long-term, and so was less affected by other factors. Therefore, over this relatively short period, we consider temperature and precipitation to be the main factors affecting the growth of plants. Actually, the Spearman analysis (Table 5), showed that there was no significant correlation between important value and precipitation.

Table 5 Coefficient relationship between most common species' important value and precipitation

Species	Correlation coefficient	Significant level
Stipa krylovii	0.7578	0.1378
Leymus chinensis	0.6564	0.2289
Allium polyrhizum	-0.0794	0.8990
Potentilla bifurca	-0.1046	0.8670
Artemisia anethifolia	-0.2218	0.7199
Reaumuria soongorica	-0.6959	0.1918
Atriplex sibirica	-0.4835	0.4093
Suaeda salsa	-0.3553	0.5574
Cleistogenes squarrosa	-0.4035	0.5501

Table 6, shows that there was a negative correlation between winter maximum temperature and *Cleistogenes squarrosa*, *Atriplex sibirica* (*P*□0.05); there was no significant correlation between coverage of other species and the decrease of winter maximum temperature. Therefore, the decrease of winter maximum temperature would affect some most common specie, but not affect predominant species, and little affect the structure of S*tipa krylovii* Roshev grassland. The analysis of precipitation and coverage of most common species shows there was no significant correlation between precipitation and coverage of most common species.

Table 6 Coefficient relationship between most common species' coverage and precipitation and winter maximum temperature

Species	Coverage and winter maximum temperature		Coverage and precipitation	
	Correlation coefficient	**Significant level**	**Correlation coefficient**	**Significant level**
Stipa krylovii	-0.2786	0.6511	0.5432	0.3587
Leymus chinensis	-0.1374	0.8572	0.7214	0.1842
Allium polyrhizum	-0.3872	0.5864	-0.1721	0.8124
Potentilla bifurca	-0.4217	0.4789	-0.2214	0.7838
Artemisia anethifolia	0.6382	0.2978	-0.3443	0.5872
Reaumuria soongorica	0.7732	0.1387	0.7646	0.1267
Atriplex sibirica	-0.9327*	0.0201	-0.6217	0.2618
Suaeda salsa	-0.1785	0.8012	-0.2988	0.6273
Cleistogenes squarrosa	-0.9012*	0.0378	-0.4835	0.4093

The effect of decrease of winter maximum temperature on *Stipa krylovii* Roshev grassland

Structure and function of plant communities are an important plant performance characteristic. Based on the diversity and evenness indexes of the plot during 2002-2006, the results show that the interannual fluctuations are small. Evenness index fluctuations were 0.75~0.80, compared with the baseline evenness index in 2002, and it is increased 0.25in 2006; Simpson index fluctuations were 3.97~4.67, compared with the baseline Simpson index of 2002, that of 2006 increased 7.36%. These data indicated that dominant species of 2006 are smaller than that of 2002. However, interannual variability of the Shannon-Wiener index is large. Shannon- Wiener index fluctuations were 1.64~1.76. The Shannon-Wiener index was highest in 2003, compared with the Shannon-Wiener index of 2002. By 2006 the index had increased 0.56. So species of plant community in 2003 is the largest, and also this index of species of in 2006 is more than that of 2003.

As can be seen from Table 8, there is no significant correlation between the diversity index, evenness index and maximum temperature. This indicates that in the five year period of the study, the *Stipa krylovii* Roshev grassland community is less affected by the decrease in winter maximum temperature, and that the decrease in winter maximum temperature would not obviously affect the structure and function of *Stipa krylovii* Roshev grassland.

Table 7. Changes of community characteristics of *Stipa krylovii* grassland

Community characteristics value	Year				
	2002	**2003**	**2004**	**2005**	**2006**
Shannon-Wiener index	1.643	1.752	1.690	1.697	1.699
Evenness index	0.748	0.797	0.769	0.772	0.773
Simpson index	3.979	4.544	4.207	4.661	4.272

Table 8. Coefficient relationship between characteristics of *Stipa krylovii* grassland and winter maximum temperature

	Shannon-Wiener index	Simpson index	Evenness index
Correlation coefficient	-0.3533	-0.7105	-0.347
Significant level	0.5597	0.1786	0.5672

Discussions

Currently, climate change has become a research. This paper analyzes five consecutive years of data (collected between 2002 and 2006), and results show that annual average temperature in Hulun Buir *Stipa krylovii* Roshev grassland had a fluctuating decline five year period. Climate change is not a uniform process, the minimum temperature changed more obviously than maximum temperature; winter temperature changed more obviously than summer temperature (Boutton & Tieszen, 1988). There is, however, no evidence to indicate that the response of plants to minimum temperature and maximum temperature is the same as the response of plants to average temperature (Alward & Dentling, 1999; Easterling & Horton, 1997; Houghton, Griggs & Ding, 2001). Therefore, to understand the trend and degree of climate change, we must pay attention to changes in characteristics of climate change, clarify temperature changes, determine the mechanisms that impact asymmetric temperature change on plants. All of these are key factors in understanding the response of plants to global climate change and in developing coping strategies.

Scholars have done a lot of research on the effect of climate change on the dominant species of grassland communities. Results suggest that climate change will affect the importance value of dominant species, but there is little impact on its function and status in community structure (Liu & Lin, 2006). This paper investigated the effect of winter maximum temperature on nine most common species. With the fluctuating decline in winter maximum temperature, the important value of *Stipa krylovii* and *Leymus chinensis* as predominant species decreased, but there is no significant correlation; other most common species such as *Potentilla bifurca*, *Atriplex sibirica*, *Suaeda salsa*, *Reaumuria soongorica* showed complementary relationship. There was a negative correlation between *Cleistogenes squarrosa* and winter maximum temperature. The complementary relationship of competitiveness of similar species to environmental change will cause the increasing complexity of dynamic changes of community species, if this situation continues long-term; it will change the structure and function of community. Extensive research on *Leymus chinensis*, has come to the same conclusion (Zhou, Liu & Lin, 2006). Other studies have used mathematical simulations to show that when the community is affected, species intensity order in the set will change, the status of species in the community will change too (Lin & Larry, 2003). However, in this study, the effect of climate change on predominant species is small.

Some scholars believe that the response of individual species to climate change will lead to community level changes (Kardol & Cregger, 2010). The response mechanism of different communities to climate change differs, and so a community needs to change its structure in order to adapt to changing climate (Gao, Li & Zheng, 1996). Huang, Li and Yuan (2008) researched *Haloxylon ammodendron*, the results showed that climate change has caused the *Haloxylon ammodendron* community to exhibit retrogressive succession. In this paper, the correlation between characteristics index of community and winter maximum temperature, shows that winter maximum temperature would not affect the structure and function of *Stipa krylovii* Roshev grassland community. However, the Shannon-Wiener index of 2006 is higher than that of 2002, meaning there were more species in the community in 2006 compared to that of 2002. This indicates that new species moved into the community, making this community more complex. The Simpson index of 2006 is higher than that of 2002, indicating that the ratio of predominant species in 2006 is lower than that in 2002, so we infer that with time, temperature continues to decreased, the statues of *Cleistogenes squarrosa* in the community will change, which will affect the structure and function of the community.

Conclusions

During the five year period of this study, the decrease of winter maximum temperature will cause a decrease in average temperature in *Stipa krylovii* Roshev grassland; *Cleistogenes squarrosa* was sensitive to the response of temperature change; *Stipa krylovii* and *Leymus chinensis* as predominant species changed minimally; there was no significant correlation between temperature and characteristics index of community. Although several plants were sensitive to the change in winter maximum temperature, there was no significant impact on structure and function of *Stipa krylovii* Roshev grassland community during these five years.

References

Alward, R. D. & Dentling, J. K. 1999. Grassland vegetation changes and nocturnal global warming. *Science*, 283: 229-231.

Boutton, T. W. & Tieszen, L. L. 1988. Biomass dynamics of grassland vegetation in Kenya. *African Journal of Ecology*, 26: 89-101.

Chinese Academy of Sciences' Inner Mongolia and Ning xia expedition (1985). *The vegetation of Inner Mongolia*. Beijing,Sciences Press, 42-58.

Easterling, R. D. & Horton, B. 1997. Maximum and minimum temperature trends for the global. *Science*, 277: 364-367.

Fang, J. 2001. Re_discussion about the forest vegetation zonation in Eastern China. *Acta Botanica China*, 43: 522-533.

Gao, Q. Li, J.D. & Zheng, H.Y. 1996. A modeling study on response of alkaline grassland ecosystems to climate change in light of diversity and spatial patterns. *Acta Botanica Sinica*, 38: 18-30.

Houghton, J. T., Griggs, D. J. & Ding, Y. 2001. *Climate change 2001: The scientific basis. Summary for policymakers and technical summary of the working group report*. Cambridge UK: Cambridge University, 98.

Huang, P.Y., Li, Q.J. & Yuan, Q.F. 2008. Effect of climate change on *Haloxylon ammodendron* community in southern edge of Zhunger basin. *Acta Ecologica snica*, 28: 6051-6059.

Jekison, D. S. & Admas, D. E. 1991. Model estimates of CO_2 emissions from soil in response to global warming. *Nature*, 351: 304-306.

Jian, N. 2011. Impacts of climate change on Chinese ecosystems: Key vulnerable regions and potential thresholds. *Regional Environmental Change*, 11: 49-64.

Kardol, P. & Cregger, M.A. 2010. Soil ecosystem functioning under climate change: plant species and community effects. *Ecology*, 91: 767-781.

Krankina, O.N. & Dixon, R.K. 1997. Global climate change adoption: examples from Russian boreal forests. *Climatic Change*, 36: 197-215.

Liu, C., Fan, R. & Wu, J. 2009. Temporal lag of grassland vegetation growth response to precipitation in Xilinguolemeng. *Arid Lang Geography*, 32: 512-518.

Liu, Q. & Lin, Z. 2006. Response of first 6 dominant species of Leymus chinensis grassland in Inner mongolia to Climate change. *Process in Geography*, 25: 63-71.

Luo, W., Wu, Y. & Zhang, F. 2011. Root characteristics under different grazing intensities in *Stipa Krylovii* steppe. *Chinese Journal of Ecology*, 30: 2692-2699.

Li, X., Li, X. & Wang, H. 2006. Impact of climate change on temperate grassland in northern China. *Journal of Beijing Normal University (Natural Science)*, 46: 618-623.

Lin, Z. & Larry, L. 2003. The evolution characters of the best competitor of meta population. *Acta Ecologica Sinica.*

White, T.A. & Campbell, B.D. 2001. Sensitivity of three grassland communities to simulated extreme temperature and rainfall events. *Global Change Biological*, 6: 667-684.

Wang, Y. & Zhou, G. 2004. Response of *Leymus chinensis* grassland vegetation in Inner Mongolia to temperature change. *Acta Phytoecologica Sinica*, 28: 507-514.

Yuan, W. 2007. Research on phenology characteristics of typical steppe and its impact on the ecosystem function. *Beijing: Institute of Chinese Plant Science*,16-17

Yang, X., Zhao, X. & Na, R. 2010. Response of phenology variation characteristics of typical steppe vegetation in Inner Mongolia to climate change, *Inner Mongolia Prataculture*, 3: 51-56.

Zhou, G. & Zhang, X. 1997. Experiment and modelling on the response of Chinese terrestrial ecosystems to global change. *Acta Botanica Sinica*, 39: 879-888.

Zhou, Q., Liu, Q. & Lin, Z. 2006. Effects of global warming on most common species of *Leymus chinensis* in Inner Mongolia of China. *Chinese Journal of Ecology*, 25: 24-28.

Zhang, X., Ge, Q. & Zheng, J. 2005. Impacts and lags of global warming on vegetation in Beijin for the last 50 years based on remotely sensed data and phonological information. *Chinese Journal of Ecology*, 24: 123-130.

Addition to the Flora of Mongol Daurian Phytogeographical Region in Mongolia

Magsar Urgamal, Chinbat Sanchir

Institute of Botany, Mongolian Academy of Sciences, Mongolia,
urgamal@botany.mas.ac.mn

Abstract: The about new floristic findings of Mongol Daurian phytogeographical region in Mongolia, which was on the species level have been made since Gubanov`s conspectus (1996). The article reports on the new records of 83 species belonging to 63 genera,21 genera added, and 24 families (one family added) in the Mongol Daurian phytogeographical region to the flora of Mongolia. At a present, a total of 1,289 species of the vascular plants are distributed in this phytogeographical region. The first time, we were added of a species, which is *Hedysarum chalchorum* N. Ulziykh, is endemic, and three species, *Saussurea purpurata* (Fisch. ex Herder) Lipsch., *Viola rudolfii* V. Nikit., *V. schauloi* V. Nikit., are subendemic plants in the Mongolian flora.

Keywords: *Vascular flora, new species, Mongol Daurian, phytogeographical region, Mongolia*

Introduction

Mongolia's Daurian forest steppe ecoregion encompasses portions of the Khentii Mountain Range and includes numerous large rivers such as the Onon and the Ulz. Siberian larch forests, which include numerous herb species, birch pine, and aspen groves are characteristic for this area. The trans-boundary international protected area network of Dauria (Figure 1), is composed of Daurskii Zapovednik territories in the Chita region of Russia, Mongol Daguur SPA (1,030,000 hectares) in Mongolia, and the Dalai Nuur Nature Reserve in China. There are also two protected areas in the Mongolian portion of the region, namely, Onon-Balj National Park (4,157,000 ha), and Ugtam Uul Nature Reserve (462,000 ha).

Figure 1. The trans-boundary international protected area network of Dauria

The Red Data Book of Mongolia (2013) recognizes the following floral species distinctions in this ecoregion: fifteen are considered very rare, 4 species rare, 8 species endemic, thirteen subendemic plant species. Six of these are: *Sophora flavescens, Rhododendron dauricum, Caryopteris mongolica, Valeriana officinalis, Vicia tsydenii and Adonis mongolica.*

The first attempt to explore the flora of Mongolia is credited to D.G. Messerschmidt, who collected the first herbariums from north-eastern Mongolia, particularly, the valleys of Ulz and Onon rivers. The first inventory list of vascular plants of Mongolia including 489 species was put together by K.I. Maximovicz in 1859. The researchers were followed by dozens of scientists, mostly from Russia, Poland, Germany and other countries.

The main work on the vascular flora of Mongolia have been "Survey of Flora of Mongolia" by Ulziykhutag (1989) and some sources can be found in Table 1, and the conformity of Mongolian territory with the phytogeographical classification by V.L. Komarov in 1908 and several works on this issue (Ulziykhutag, 1989).

Table 1.Overview of the flora in the Mongol Daurian phytogeographical region of Mongolia

Sources and references	Species number
Ulziykhutag, N. (1989)	946
Ariuntsetseg, L.& Boldgiv, B. (2009)	1247
Urgamal, M., Oyuntsetseg, B. &Nyambayar, D. (2013)	1281
At present	1289

Mongolia is divided into sixteen phytogeographical regions based on floral composition, vegetation and geographical characteristics (Grubov, 1982). A detailed historical review of these research efforts could be found in the works by Ulziikhutag (1989), Hilbig (1995) and Gubanov (1996). Moreover, some families and genera of vascular plants, as well as phytogeographical regions are revised by researchers. For example, a monograph of flora and vegetation of East Mongolia was published by Dashnyam (1974).

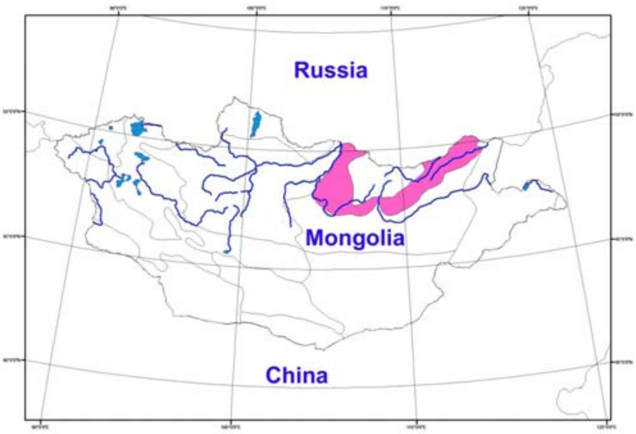


Figure 2. Map of Mongol Daurian phytogeographical region of Mongolia

Materials and Methods

The Herbarium (UBA) of the Institute of Botany, MAS contains more than 125,000 specimens, and Herbarium (UBU) of the Department of Botany, NUM contains about 12,000 specimens. In total 137,000 specimens represent more than 2,745 species of vascular plants belonging to over 640 genera and 108 families. The Database *of the Mongolian Flora* includes about 3,050 species (included cultivated plants) of vascular plants belonging to more 680 genera in 113 families (Urgamal, 2012).

Nomenclature is based on Gubanov (1996) and according to APG III (2009), IPNI (2013), WCSP (2013) and APWeb (version 13. 2013).Many recent studies have provided support for the APG (LAPG) III (2009) system, which is adopted here, too. The families in the conspectus are arranged according to APG III system, genera and species in the alphabetic order.

Results

The collection were added 83 species belonging to 63 genera, 21 genera added, and 24 families, one family added, in the Mongol Daurian phytogeographical region to the flora of Mongolia, the since of Gubanov`s (1996) conspectus in Table 2. At a present, a total of 1289 species of vascular plants are distributed in this phytogeographical region. The most newly added genera and species number of followed families in the Mongol Daurian phytogeographical region of Mongolia: Fabaceae (10/14),Asteraceae (9/12), Poaceae (8/11), Apiaceae (5/5), Viola (1/5).

The first time, we have added of one species (*Hedysarum chalchorum* N. Ulziykh.) that is endemic for Mongolia, and three species (*Saussurea purpurata* (Fisch. ex Herder) Lipsch., *Viola rudolfii* V. Nikit., *V. schauloi* V. Nikit.) that are subendemic for Mongolian flora.

Table 2. List of new records in the Mongol Daurian phytogeographical region of Mongolia (families arranged according to APG III system, 2009)

New added species name (genera/species)	Sources and references
1. Onocleaceae Pic. Serm. (1/1)	Dulamsuren & Muhlenberg, 2003
Matteuccia struthiopteris (L.) Todaro	Galanin et al., 2008
2. Pinaceae Spreng. ex Rudolphi(1/1)	Galanin et al., 2008
Larix czekanowskii Szafran	
3. Iridaceae Juss.(1/2)	Galanin, 2009
Iris pseudothoroldii Galanin	Zumberelmaa, 2004, 2009; Galanin, 2009
I. sibirica L.	
4. Asparagaceae Juss. (1/1)	Galanin & Belikovich, 2011
Asparagus burjaticus Peschkova	
5. Juncaceae Juss.(1/1)	Galanin et al., 2008
Juncus virens Buchenau	
6. Cyperaceae Juss.(1/1)	Nyambayar, 2009, 2011
Carex norvegica	
7. Poaceae Barnhart(8/11)	Galanin, 2009
Avena sativa L.	
Calamagrostis angustifolia subsp. *tenuis*	Galanin, 2009
(V.N. Vassil.) Tzvelev	Dulamsuren & Muhlenberg, 2003
Cinna latifolia (Trev.) Griseb.	Manibazar, 2010
	Galanin, 2009
	Galanin, 2009
Dactylis glomerata L.	Clayton et al., 2006; Galanin, 2009
Elymus kronokensis (Kom.) Tzvelev	Galanin, 2009
Festuca jacutica Drobov	Gubanov, 1999; Dariimaa, 2009

F. pseudosulcata Drobov	Galanin, 2009
Poa attenuata subsp. *tshuensis* (Serg.) Olon.	Ariunsuren, 2006
P. ircutica Roshev	Grubov, 1982; Urgamal et al., 2013
P. pratensis subsp. *pruinosa* (Korotky) Dickore	
Triticum aestivum L.	Munkh-Erdene & Urgamal, 2013
8. Papaveraceae Juss. (1/1)	
Corydalis sajanensis Peschkova	Munkueva, 2003
9. Ranunculaceae Juss.(2/3)	Munkueva, 2003
Aconitum macrorhynchum Turcz. ex Ledeb.	Grubov, 1982; Urgamal et al., 2013
A. ranunculoides Turcz.	
Ranunculus pulchellus C.A. Mey.	Urgamal et al., 2013
10. Caryophyllaceae Juss.(1/1)	
Silene foliosa Maxim.	Lomonosova et al.,2008
11. Amaranthaceae Juss.(1/2)	
Suaeda corniculata subsp. mongolica	Lomonosova et al.,2008
Lomon. & Freitag	
S. sibirica Lomon. & Freitag	Kamelin et al., 2011
12. Violaceae Batsch.(1/5)	Kamelin et al., 2011
Viola alexandrowiana (W. Becker) Juz.	Kamelin et al., 2011
V. arvensis Murray	Kamelin et al., 2011
V. rudolfii V. Nikit.	Kamelin et al., 2011
V. schauloi V. Nikit.	
V. tenuicornis subsp. *trichosepala* W. Becker	Grubov, 1982
13. Fabaceae Lindl.(10/14)	Ulziykhutag, 2003; Dariimaa, 2009
Astragalus chorinensis Bunge	Ulziykhutag, 2003; Dariimaa, 2009
Glycyrrhiza soongorica Grankina	Ulziykhutag, 2003; Dariimaa, 2009
Hedysarum chalchorum N. Ulziykh.	Ulziykhutag, 2003
H. gmelinii Ledeb	Ulziykhutag, 2003
Lathyrus sativus L.	Ulziykhutag, 2003
Lotus corniculatus L.	Ulziykhutag, 2003
Onobrychis arenaria (Kit.) DC.	Ulziykhutag, 2003
Ornithopus perpusillus L.	Dariimaa, 2009
Pisum arvense L.	ILDIS, 2013
Thermopsis dahurica Czefr.	Ulziykhutag, 2003
Th. lanceolata var. lanceolata R. Br.	Vlasova, 2012
Vicia faba L.	Ulziykhutag, 2003; Dariimaa, 2009
V. nervata Sipliv.	
V. ramuliflora (Maxim.) Ohwi	Grubov, 1982; Urgamal et al., 2013
14. Rosaceae Juss.(2/3)	
Amygdalus pedunculata Pall.	Kechaykin & Shmakov, 2013
	Urgamal et al., 2013
Potentilla nivea subsp. *arenosa* (Turcz.) Kuvaev	Kechaykin & Shmakov, 2013
	Urgamal et al., 2013
P. supina var. *supina*	
	Gubanov, 1999; Dariimaa, 2009
15. Rhamnaceae Juss. (1/1)	
Rhamnus davurica Pall.	Gubanov, 1999; Dariimaa, 2009
16. Lythraceae J. St.-Hil. (1/1)	
Lythrum salicaria L.	Neuffer et al., 2012
17. Brassicaceae Burnett (4/4)	Neuffer et al., 2003
Berteroa incana (L.) DC.	Grubov, 1982
Draba lanceolata Royel	Smirnov et al., 2003; German & Oyuntsetseg, 2008;
Lepidium ruderale L.	German, 2009; Neuffer et al., 2012
Sisymbrium volgense M. Bieb. ex E. Fourn.	
	Urgamal et al., 2013
18. Ericaceae Juss. (2/3)	Urgamal et al., 2013
Cassiope ericoides (Pall.) D. Don. 1834	Grubov, 1982; Urgamal et al., 2013
Empetrum nigrum L.	
E. nigrum subsp. *sibiricum* (V.N. Vassil.) Kuvaev	Ovchinnikova S.V. 2005
19. Boraginaceae Juss. (2/3)	Ovchinnikova S.V. 2005
Lappulaanisacantha (Turcz. ex Bunge) Gurke	Gubanov, 1999

L. redowskii (Hornem.) Greene	Gubanov, 1999; Dariimaa, 2009
Myosotis caespitosa Schultz	
20. Scrophulariaceae Juss. (1/1)	Gubanov, 1999; Dariimaa, 2009
Verbascum thapsus L.	Neuffer et al., 2012
21. Lamiaceae Martinov (4/4)	Kamelin & Darijmaa, 2002; Darijmaa, 2009
Dracocephalum olchonense Peschkova	
Mentha aquatica L.	Krestovskaja, 2004
Scutellaria dependens Maxim.	
Stachys aspera subsp. *baicalensis*	Grubov, 1982; Ulziykhutag, 1985
(Fisch. ex Benth.) Krestovsk.	Urgamal et al., 2013
22. Asteraceae Bercht. & J. Presl (9/12)	Grubov, 1982; Neuffer et al., 2012
Achillea millefolium L.	Urgamal et al., 2013
	Grubov, 1955; Urgamal et al., 2013
A. ptarmicoides Maxim.	Grubov, 1982; Urgamal et al., 2013
	Dariimaa, 2009; Urgamal et al., 2013
Artemisia dahurica (Turcz.) Poljakov	Dariimaa, 2009; Urgamal et al., 2013
Erigeron elongatus Ledeb.	Gubanov, 1999; Dariimaa, 2009, 2014
Heteropappus medius Tamamsch.	Gubanov, 1999; Dariimaa, 2009, 2014
Leontopodium palibinianum Beauverd	Dariimaa, 2009, 2014
Saussurea purpurata (Fisch. ex Herder) Lipsch.	Sanchir, 2004; Dariimaa, 2009, 2014
Serratula cardunculus (Pall.) Schischk.	Sanchir, 2004; Dariimaa, 2009, 2014
Taraxacum armeriifolium Soest	Gubanov, 1999; Dariimaa, 2009
T. commixtiforme Soest	
T. glaucanthum (Ledeb.) DC.	Urgamal, 2004, 2009, 2013
Turczaninowia fastigiata (Fisch.) DC.	Urgamal, 2009, 2013
23. Apiaceae Lindl. (5/5)	Urgamal, 2012, 2013
Anethum graveolens L.	Ligaa, 1996; Urgamal, 2009, 2013
Apium graveolens L.	Urgamal, 2009, 2013
Bupleurum pusillum Krylov	
Coriandrum sativum L.	Ochirbat, 2009; Urgamal et al., 2013
Pastinaca sativa L.	Ulziykhutag, 1985; Sanchir, 2000
24. Caprifoliaceae Juss. (2/2)	Grubov, 2001
Lonicera tatarica L.	
Valeriana officinalis L.	
Total:83 species, 63 genera and 24 families	

Discussion

The first time, new 21 genera (*Amygdalus, Anethum, Apium, Berteroa*, *Cassiope, Cinna, Coriandrum, Dactylis, Empetrum, Lonicera, Lotus, Lythrum, Matteuccia, Onobrychis, Ornithopus, Pastinaca, Pisum, Stachys, Triticum, Turczaninowia*, *Verbascum*) and one family (Onocleaceae) have been registered in the Mongol Daurian phytogeographical region since of Gubanov`s (1996) conspectus.

References

APG. (Angiosperm Phylogeny Group) III. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal Linnean Society*, 161: 105-121.

APWeb (Angiosperm Phylogeny Website). 2013. <http://www.mobot.org/MOBOT/research/APweb/>

Ariunsuren, P. 2006. Rod Myatlik (PoaL.) Mongolii i Vnutrennei Mongolii. Abstract of Thesis. Ulaanbaatar, Mongolia. (in Russian).

Ariuntsetseg, L. & Boldgiv, B. 2009. On the quantitative aspects of the flora Mongolia. *Mongolian Journal of Biological Sciences*, 7: 81-84.

Dariimaa, Sh. 2009. New added species to the flora of Mongolia. Proceedings of the Institute of Botany, Mongolian Academy of Sciences. 21: 44-50. (in Mongolian).

Dariimaa, Sh. 2014. Flora of Mongolia. (Asteraceae, Cichorioideae - Carduoideae). 14a volume. Ulaanbaatar, Mongolia, “Bembi san” Press. (in Mongolian).

Dariimaa, Sh. & Kamelin, R.V. 2002. Novievididlya flory Mongolii I otdelnikhikhraionov. Proceedings of the International Conference on Biodiversity of Mongolia. Ulaanbaatar, Mongolia: 21-23. (in Russian).

Dariimaa, Sh., Bayanmunkh, T. & Jimsee, D. 2004. Flora of the nearest in Ikh Nart station. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*, 15: 68-73. (in Mongolian).

Dashnyam, B. 1974. Flora and vegetation of Eastern Mongolia. Publishing of Academy of Science

Ulaanbaatar. (in Mongolian).

Dulamsuren, Ch. & Muhlenberg, M. 2003. Additions to the flora of the Khentej, Mongolia, 1. *Willdenowia*, 33: 149-158.

Friesen, N.V. & Oyuntsetseg, B. 2013. Biogeography and phylogeny of genus Allium L. (Amaryllidaceae) in Mongolia and adjacent territories. Proceedings of International Conference on Plant Biodiversity and Ecosystem Services in Continental Asia, Ulaanbaatar, Mongolia, 26-27, June: 22-23.

Galanin, A.V., Belikovich, A.V. & Khanko, O.V. 2008. Flora of Dahurica. (vascular plants) vol. 1: Dalnauka, Vladivostok: BGI FEB RAS. (in Russian).

Galanin, A.V. 2009. Flora of Dahurica. (vascular plants) vol. 2: Dalnauka, Vladivostok: BGI FEB RAS. (in Russian).

Galanin, A.V. & Belikovich, A.V. 2011. Flora of Dahurica. (vascular plants) volume 3. Cyperaceae, Liliaceae.Dalnauka, Vladivostok: BGI FEB RAS. (in Russian).

German, D.A. 2009. A check-list and the system of the Cruciferae of Altai.Komarovia, 6(2): 83–92. (in Russian).

German, D.A. & Oyuntsetseg, B. 2008. Cruciferae (Brassicaceae) of Mongolia updated: Comprehensive state of studies on taxonomy, diversity and geography of Mongolian Mustards. – Pp. 42-47, in: "Problems of Botany of South Siberia and Mongolia". (Chief-ed.: A.I. Shmakov). Proc. 7st Intern. Scientific-Practical Conference. Barnaul, Russia. (in Russian).

Grankina, V.P. 2001. Generis Glycyrrhiza L. (Fabaceae) species novie ex Asia Centrali. Novosti Syst. Vyssh. Rast. 33: 145-151. (in Russian).

Grubov, V.I. 1982. Key to the vascular plants of Mongolia (with an atlas). - Leningrad, Nauka: 442p. (in Russian).

Grubov, V.I. 1984. Endemic species of Mongolia. Novosti Syst. Vyssh. Rast. 21: 202-220. (in Russian).

Grubov, V.I. 2000. Conspectus generis Cynanchum L. Specierum Asiae Centarlis. Novosti Syst. Vyssh. Rast. 32: 129-135. (in Russian).

Grubov, V.I. 2001. Conspectus familiae Valerianaceae Asiae Centarlis. Novosti Syst. Vyssh. Rast. 34: 210-218. (in Russian).

Gubanov, I.A. 1996. Conspectus of flora in Outer Mongolia.Moskva, Valang. (in Russian).

Gubanov, I.A. 1999. Addition and corrections to the "Conspectus in flora of Outer Mongolia (vascular plants)". Turczaninowia 2: 20. (in Russian).

International Legume Database & Information Service. (ILDIS).<http://www.ildis.org>

International Plant Names Index.(IPNI).<http://www.ipni.org/ipni/plantnamesearchpage.do>

Kamelin, R.V., Gubanov, I.A., Darijmaa, Sh. & Ganbold, E. 1992. Sosudistyerasteniyachrabta Eren-Daba (MongolskayaDauriya). Bot. Zhurn. 77: 10-21. (in Russian).

Kamelin, R.V., Darijmaa, Sh. & E. Ganbold. 2011. Key and brief conspectus of the genus Viola L. in Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*. vol. 23: 26-33. (in Mongolian).

Kechaykin, A. & Shmakov, A.I. 2013. Systematics and species composition of the genus Potentilla L. (Rosaceae) in Mongolia. Proc. of Int. Conf. Plant Biodiversity and Ecosystem Services in Continental Asia, Ulaanbaatar, Mongolia. 85-87.

Krestovskaja, T.V. 2004. Genus Campanula L. (Campanulaceae) in Asia Centrali. Novosti Syst. Vyssh. Rast. 43: 218-222. (in Russian).

Ligaa, U. 1996. Medicinal plants of Mongolia used in Mongolian Traditional Medicine. Seoul. (in English and Korean)

Lomonosova, M.N. & Freitag, H. 2003. A new species of Suaeda (Chenopodiaceae) from the Altai, Central Asia. *Willdenowia*, 33: 139-147. (in Russian).

Lomonosova, M.N., Brandt, R. & Freitag, H. 2008. Suaedacorniculata (Chenopodiaceae) and related new taxa from Eurasia. *Willdenowia*, 38: 81-109.

Manibazar, N. 2010. Dictionary of latin-mongolian species name of vascular plants in Mongolia. Ulaanbaatar. (in Mongolian).

Maximowicz, K.J. 1889. Enumeratioplantarumhucusque in Mongolia nec non adjacenta parte Turkestaniaesinensislectarum. Petropoli, 1: 146.

Munkueva, M.S. 2003. The review of the genus Aconitum L. (Ranunculaceae) from Baicalian Siberia. Pp. 66-73, in: "Problems of Botany of South Siberia and Mongolia". Proc. 2st Intern. Scientific-Practical Conference. Barnaul, Russia. (in Russian).

Neuffer, B., Oyuntsetseg, B., Schamsran, Z., Friesen, N. & Hurka, H. 2003. Contribution to the knowledge of the Flora of the Mongolian Altai. *Feddes Repert*. 114: 5–6, 358–371.

Neuffer, B., Friesen, N., Oyuntsetseg, B., Schamsran, Z. & Hurka, H. 2012. Osnabruck botanical expeditions to Mongolia. Erforsch. Biol. Ress. Mongolei. band 12. (Halle/Saale). 12: 307-333.

Ochirbat, G. 2009. Melliforous and pollen plants species of Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*. 21: 252-264. (in Mongolian).

Ovchinnikova S.V. 2005. Notes on some species of Lappulasection Lappula (Boraginaceae). Turczaninowia, 8: 5-19. (in Russian).

Sanchir, Ch. & Tserennadmid, P. 2000. Mongolyn kheert Shar sarnai oldloo. (Rosa xanthinaLindl.). *Proceedings of Mongolian Academy of Sciences*. 1: 24-26. (in Mongolian).

Sanchir, Ch., Batkhuu, J. & Munkhbaatar, A. 2004. New species in the Middle Khalkha steppe region. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*. 14: 6-8. (in Mongolian).

Smirnov, S.V., German, D.A., Kosachev, P.A. & Dyachenko, S.A. 2003. Addition to the flora of Mongolia. Turczaninowia, 6: 11-21. (in Russian).

Ulziikhutag, N. 1985. Tejeeliin urgamal tanikh bichig. Ulaanbaatar. 557p. (in Mongolian).

Ulziikhutag, N. 1989. Outline of Mongolian Flora. State Press Publishing House, Ulaanbaatar. (in Mongolian).

Ulziykhutag, N. 2003. Fabaceae of Mongolia. Ulaanbaatar, "Bembi san": 587p. (in Russian).

Urgamal, M. 2004. The key to the plants of family Apiaceae in Mongolia. Ulaanbaatar, Mongolia. "Jinst-Khargana" Press. (Keys in English).

Urgamal, M. 2009. Flora of Mongolia. Volume 10, (Apiaceae-Cornaceae). Ulaanbaatar, "Bembi san", 130pp. (in Mongolian).

Urgamal, M. 2012. The databases on the herbarium and the flora of Mongolia. Erforschung Biologischer Ressourcen Der Mongolei. "Biodiversity of Research in Mongolia" Halle (Saale), Germany; 25-29, March, p.39-40.

Urgamal M. 2012. Classification of the Celery family ApiaceaeLindl.1836 (Umbelliferae Juss. 1789). News of the Mongolian Academy of Sciences 4, (204)52: 36-41.

Urgamal, M. 2012. Distribution of family Apiaceae species in Mongolia. Conference of the Problem botany of the South Siberia and Mongolia. Russia, Barnaul: 226-228. (in Russian).

Urgamal, M. 2013. Brief conspectus of the family Apiaceae to the flora of Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*, 25: 38-47.

Urgamal, M., Oyuntsetseg, B. & Nyambayar, D. 2013. Synopsis and recent additions to the flora of Mongolia. *Proceedings of Institute of Botany, Mongolian Academy of Sciences*, 25: 53-72.

Zumberelmaa, D. 2004. Investigation of genus Iris L. of Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*. 15: 65-66. (in Mongolian).

Zumberelmaa, D. 2009. Taxonomical investigation of genus Iris L. of Mongolia. *Proceedings of the Institute of Botany, Mongolian Academy of Sciences*. 21: 51-55. (in Mongolian).

Effects of Precipitation on the Distribution and Characteristics of *Stipa Klemenzii* Desert Steppe in the Hulun Lake Area

Wu Liji, Liu Songtao, Gui Manquan

Dalai Lake National Nature Reserve Inner Mongolia, Hulun Buir, Inner Mongolia 021008, China

Abstract: The *Stipa klemenzii* formation is a special formation of the desert steppe zone in central Asia found around Hulunbuir lake grassland steppe. We mapped the distribution of this formation in July, 2002 and monitored species composition and distribution every year to analyze patterns of change. The results indicate stability of the formation, moreover, it turn out reality of distributing desert steppe in the Hulunbuir typical steppe zone. This phenomenon led to the conclusion that the Hulunbuir grassland steppe zone is changing to the desert steppe zone, specially drying trends, overgrazing and desertification. In the results, state species composition is more explicitly, namely the shift in species dominance.

Key words: *Hulunbuir typical steppe; Stipa klemenzii; Distribution; Desertification. Formation of desert steppe, climate change, overgrazing*

Introduction

Stipa kelemenzii Roshev is a thick, small, xerophilic, perennial grass of xeric-desert grasslands dominated by *Stipa* (Gramineae). It is one of the main species of desert steppe grass in central Asia. It is a main component of the mid-temperate, desert steppe community, and is also found widely in steppe desert zone community. It exists in Xilingol, Wulanchab (north), and Ordos (west), Bayannuur (north) and the east of Alshan. It has specific demands for habitat. It grows in top hills and stony hillside that are dry and wind-carved in steppe sub-zone and desert steppe sub-zone. It is a dominant species of pebbly desert steppe and also grows dispersedly in steppe desert community.

Materials and Methods

Study area

Study area is located in hilltop of Holboo Mountain（49º 07. 100N，117º48 .284E）in Shine Bargiin Zuun Khoshuu, in northeast of Hulun Lake and hilltop of low hills（48º 56.137N, 117º06.132E) in north of Genghis Khan Horse Tethering Stake, northwest of Hulun Lake in Shine Bargiin Baruun Khoshuu. Research area, the landform is low hills, and lies to hinterland of Hulunbuir plateau in northeast of Inner Mongolia plateau (Hulunbuir **Chorography Office, 1986**). Stony hilltops and pebbly plains were formed on the land surface by long-term wind effects. This area belongs to upper reaches of Argun valley. The Wurshun river from Buir Lake source and Kherlen River originated from east of Mongolian Khentei Mountains flow into Hulunbuir Lake from south and west. Then the Lake is connected by Dalan-olom River and Argun River (Dalai Lake Fishery in Hulunbuir, 1989). The research area has mid-temperate, semiarid and continental monsoon climate. It is long and cold in winter, but dry and windy in spring. And in autumn, the temperature is sequential low and frosts come early. Precipitation occurs mainly from June to September. Hulunbeir steppe is an extension of Mongolia-Dauria steppe in China (Liu, Li & Yong, 1987). The original vegetation type is *Stipa krylovii* typical steppe formation.

Methods

Long-term monitoring sites were chosen as low hilltops in the north of Genghis Khan Horse Tethering Stake, northwest bank of Hulunbuir Lake. Since 2002, *Stipa kelemenzii* was monitored every year from July to August. Study is selected four samples with one square meter and combined them to reflect whole and comprehensive structure, particularly go to random four samples with one square meter, take the average of whole data, and features of the vegetation community. We measured natural height, plant stem diameter and number of each plant species. The importance value of each plant species was determined by its dry weight of aerial part. Then, importance values of each species calculated as below:

Importance value = (relative density + relative weight + relative coverage) /3

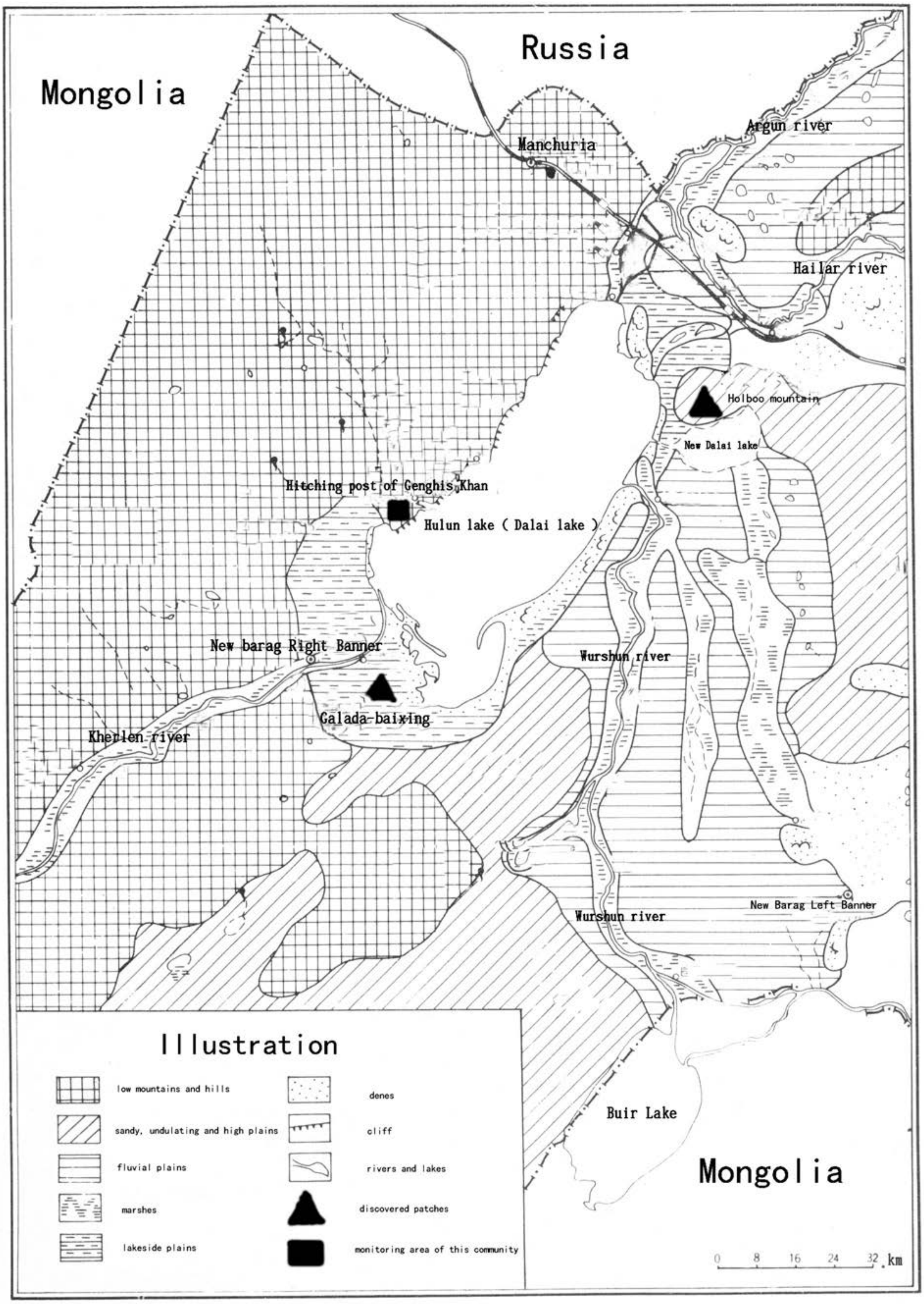


Figure 1. Distribution of landform types and community of *Stipa klemenzii* in Hulun Lake area

Results

In the Hulunbuir grassland's community, 24 species of higher plants were observed, and between ten and fourteen species are located in every square meter. Mountain meadow species were common plants in the community. *Stipa klemenzii* was the most common species among the grasses. Other species included *Stipa krylovii, Allium polyrrhizum, Caragana stenophylla, Bupleurum scorzonerifolium, Haplophyllum dauricum, Convolvulus ammannii,* etc (Table 1).

Grasses were 10 to 20 cm tall, and its cover degree was less than 20%. There were 22 species of Xerophytes which is 92% of the total species. There were 5 species of Dauria-Mongolia flora composition, and 20.8% of the total species; there were 3 species of **Central Asiatic** flora composition**, and** 12.5%the total species. **Hemicryptophytes which play a main part are 15** species**, and** 62.5% total species. There are 2 types of chamaephyte, 2 species of geophyte and 5 species of Annual or biennial herbs.

The importance value of this floristic composition shows us that *Stipa klemenzii* has become the dominant species. *Stipa Krylov*ii is widespread but not the dominant species in the communities in which it is found (Table 2). In Figure 2 and 3, all structures and performances of the community sufficiently show the desert steppe typical features of *Stipa klemenzii* in middle and west areas of Inner Mongolia (Inner Mongolia and Ningxia joint expedition, 1985; Lin et. al. 2005).

Table 1. *Stipa klemenzii* community composition based on importance values.

Species list	Importance value (%)
Stipa klemenzii	37.43
Stipa krylovii	17.57
Cleistogenes squarrosa	2.84
Agropyron cristatum	0.01
Leymus chenensis	0.01
Heteropappus aitaicus	0.01
Neopallasia pectinata	0.02
Artemisia frigida	0.03
Artemisia scoparia	0.01
Allium polyrrhizum	29.54
Allium tenuissimum	0.01
Allium bidentatum	0.01
Asparagus gibbus	0.02
Salsola collina	0.04
Axyris amrantoides	0.02
Atriplex sibirica	0.04
Caragana stenophylla	5.5
Astragalus galactites	0.03
Potentilla bifurca	0.23
Haplophyllum dauricum	1.57
Bupleurum scorzonerifolium	2.48
Carex duriuscula	0.05
Convolvulus ammannii	0.8
Ptilotrichum canescens	0.7

Table 2. Importance values in different years of main species in *Stipa klemenzii* community

Plant species	Average importance value, %	
	2002	2006
Stipa klemenzii	31.63	54.97
Allium polyrrhizum	27.28	28.54
Stipa krylovii	21.67	6.58
Caragana stenophylla	3.28	4.7
Total	83.86	94.79

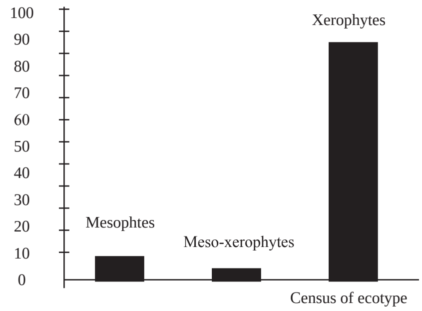


Figure 2. The census of ecotype in *Stipa klemenzii* community

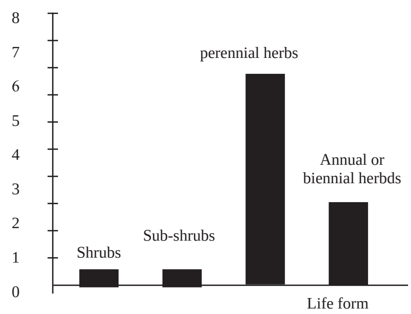


Figure 3. The census of life form in *Stipa klemenzii* community

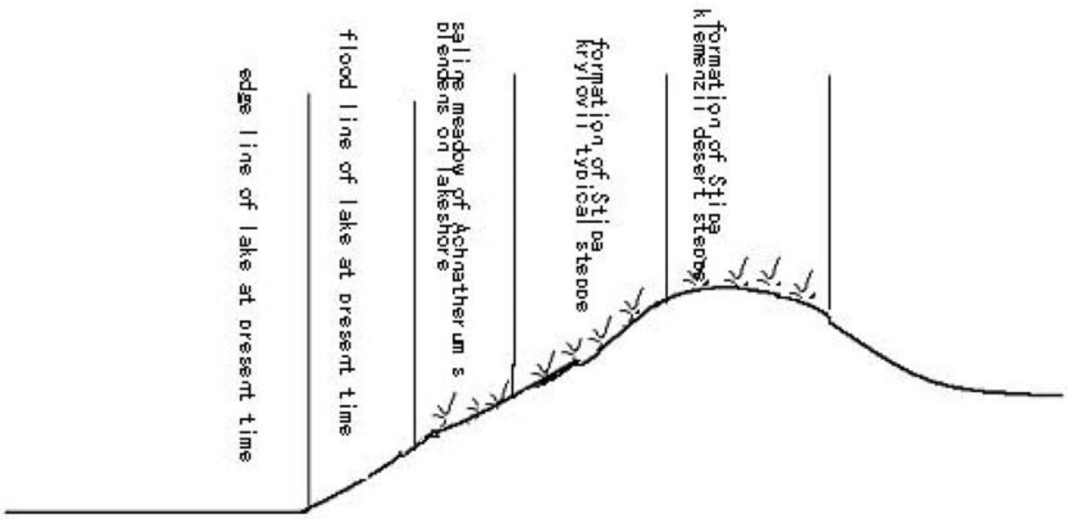


Figure 4. Ecological formation of Genghis Khan Horse Tethering Stake in the northwest bank of Hulunbuir Lake.

Discussion

In 2002, *Stipa klemenzii* did not dominate the species composition compared with *Stipa krylovii* and *Allium polyrrhizum*. Stipa klemenzii began to increase and become the dominant species of this community composition by 2005. After several years' monitoring, we can confirm that there is a real but partial formation distribution of *Stipa klemenzii* desert steppe around Hulunbuir Lake or in Hulunbuir Grasslands in a broad sense. However, its intensive distribution area is very small and island-like. The monitoring site is in the eastern part of the Mongolian plateau-hinterland of Hulunbuir steppe. This is the first published record of the community composition of *Stipa klemenzii* in Hulunbuir typical steppe.

We suggest revising the distribution information of *Stipa klemenzii,* in "China Vegetation", "Inner Mongolia Vegetation" and other types of research documents, according to identification of samples which were collected and real sample data of this vegetation community (Inner Mongolia Flora committee, 1990; Zhao & Zhang Xiaodong, 1999). We should revise the east distribution of this species in our country, as follows: stony hilltops in hinterland of Hulunbuir steppe in the east of Mongolian plateau. And formation of *Stipa klemenzii* desert steppe in the east distribution of our country can be confirmed that it exists in small patches and distributed like islands on stony hilltops in hinterland of Hulunbuir steppe in the east of Mongolian plateau (Figure 4).

In addition, we suggest that the community of *Stipa klemenzii* in our research area was not a long-standing remnant, but instead has existed only in recent years. In support of this suggestion we present the following reasons. The weather becomes dry which promote the desertification of Hulunbuir typical steppe sub-zone. First, the existence of the current community is correlated with effects of global warming, which accelerates the transpiration of surface water and reduces annual precipitation, which together makes the region's climate drier year by year. According to the monitoring **statistics of the** National Meteorological Services, the average precipitation of Shine Bargiin Baruun Khoshuu in years before 1995 was 237.7 mm, and the average **evaporation rate was 1,536 mm, which is 6.4 times** the average precipitation. From 1995 to 2005, the average precipitation was 215.4 mm in the 11 years, and the average **evaporation rate was 1,656.8 mm, which is 7.7 times of** the average precipitation. The precipitation was 593.4 mm in 1993 in this area but from 1999, the precipitation was less than 200 mm every year, and even less than 150 mm from 2003 (Figure 5). Second, as human population and livestock numbers increase, livestock foraging exceeds the grazing capacity so that the steppe vegetation worsens.

Hulunbuir steppe is located in Mongolia-Dauria steppe ecological region, an area of global conservation concern. If we can conserve these key areas then 95% of the global species diversity can be conserved and some of the endangered species will not disappear. It shows the important position of Hulunbuir steppe in the world. Grassland degeneration is the **outstanding problem for the natural grasslands in China, and has threatened the normal development of society and economy. Now the emerging of** *Stipa klemenzii* formation makes people realize the terrible trend of area desertification. The most important task is to protect grassland resources, manage them strictly, use them rationally and develop them continually.

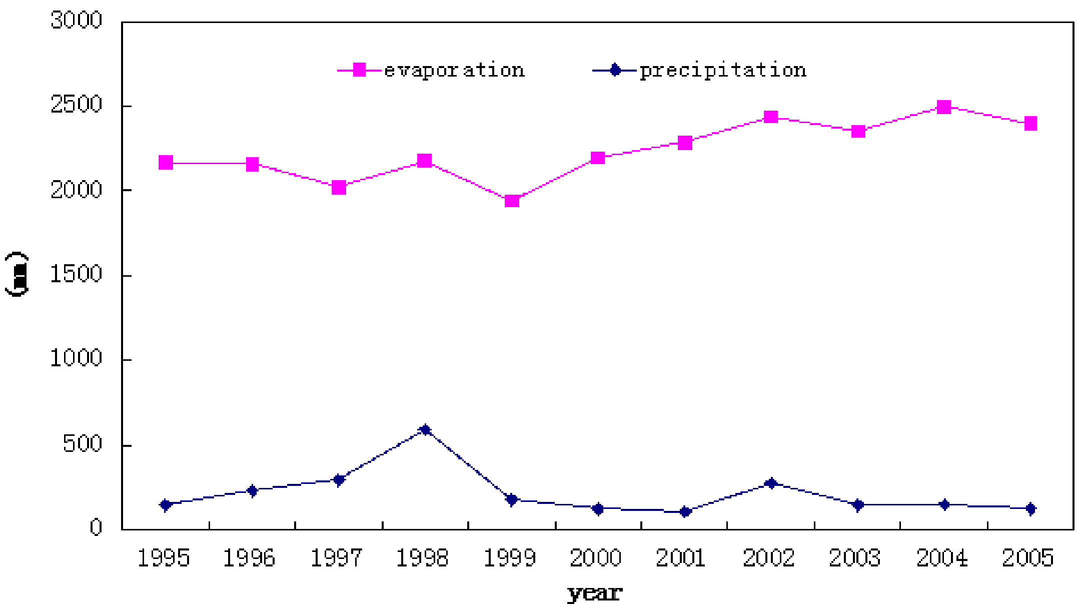


Figure 5. Precipitation and evaporation of New Barag Right Banner from 1995 to 2005

References

Inner Mongolia and Ningxia joint expedition. 1985. *Inner Mongolia Vegetation*, Science Press: 326,542-545.

Inner Mongolia Flora committee. 1990. *Inner Mongolia Flora*, Beijing:Inner Mongolia People's publishing House: 196-202.

Liu, Z., Li, B. & Yong, S. **1987**. *Area features and utilization directions of natural resource in Inner Mongolia in scientific achievements of plant ecology*, **Inner Mongolia Natural Resource Research of** geobotanical **teaching and research office of biology department in Inner Mongolia University:845.**

Hulunbeir **Chorography Office. 1986.** *Hulunbuir Emotion*, **Beijing:**Inner Mongolia People's publishing House:14.

Dalai Lake Fishery in Hulunbuir. 1989. *Hulunbuir Lake in Inner Mongolia*, Jilin Literature and History Press: 16-22, 34-37.

Lin, C., Zhu, T., Yang, Y.,Wang, J. & Liu, L. 2005. Brief Comment on Scientific Outlook on Development and Grassland Ecological Building, *China Steppe bulletin*: 64-67.

Zhao, H. & Zhang, X. 1999. Study on ecological position of *Stipa klemenzii* formation in Xilinhaote, Environmental Protection in Inner Mongolia, *China Steppe bulletin*: 11-13.

Bat Diversity and Conservation in Mongol Daguur SPA Region in the North-Eastern Mongolia.

Munkhnast Dalannast

WWF Mongolia Programme Office, Ulaanbaatar-14192, Mongolia,e-mail: munkhnast@wwf.mn

Abstract: We studied bats in the north-eastern part of Mongolia using morphometry of the skull (20) and body in 21 specimens which was collected from 2006, 2007 and 2011. During the 3 year study period, we captured and measured two species such as particolored bat (*Vespertilio murinus* Linnaeus, 1758) and Asian particolored bat (*Vespertilio sinensis* Peters, 1880) in eastern steppe of Mongolia. These bats' distribution area is wide spread in Mongolia except *Vespertilio sinensis.* The species' distribution in the eastern and central part of Mongolia is random and limited. We identified important habitats of bats in open steppe region and threats.

Key words: c*onservation, Vespertilio murinus, Vespertilio sinensis, Chukh Lake, Mongol Daguur SPA region, Mongolia.*

Introduction

At present, a total of 128 species of mammals have been recorded in Mongolia (Clark et al. 2006). Bats are one of the least studied mammal groups in Mongolia, and not sufficiently known about the biology and ecology of many bat species in the country. Until recently, 16 vespertilionid bat species occurs in Mongolia (Allen, 1938; Bannikov, 1954; Stubbe & Chotolchu, 1968; Dulamtseren, 1970; Sokolov & Orlov, 1980; Mallon, 1985; Clark et al. 2006; Dolch et al. 2007; Lebedev et al. 2010; Nyambayar et al. 2010; Datzmann et al. 2012). At present Mongolian bat fauna consists of 20 bat species (Ariunbold, 2011) that belong to the family Vespertilionidae. This study had two fold purpose: first, we aimed to collect basic information on the species diversity, population and habitat of bats in this region. Secondly, to understand the biology, ecology and threats to bats in Mongol Daguur SPA region in north-eastern Mongolia.

Materials and Methods

The study was conducted in various seasons and localities from 2006, 2007, and 2011 in Mongol Daguur SPA region in the north-eastern Mongolia (Figure 1). We conducted mist netting and the use of harp traps to catch bats. Both are well-established research methods. The specimens were measured morphological characteristics and cranial measurements.

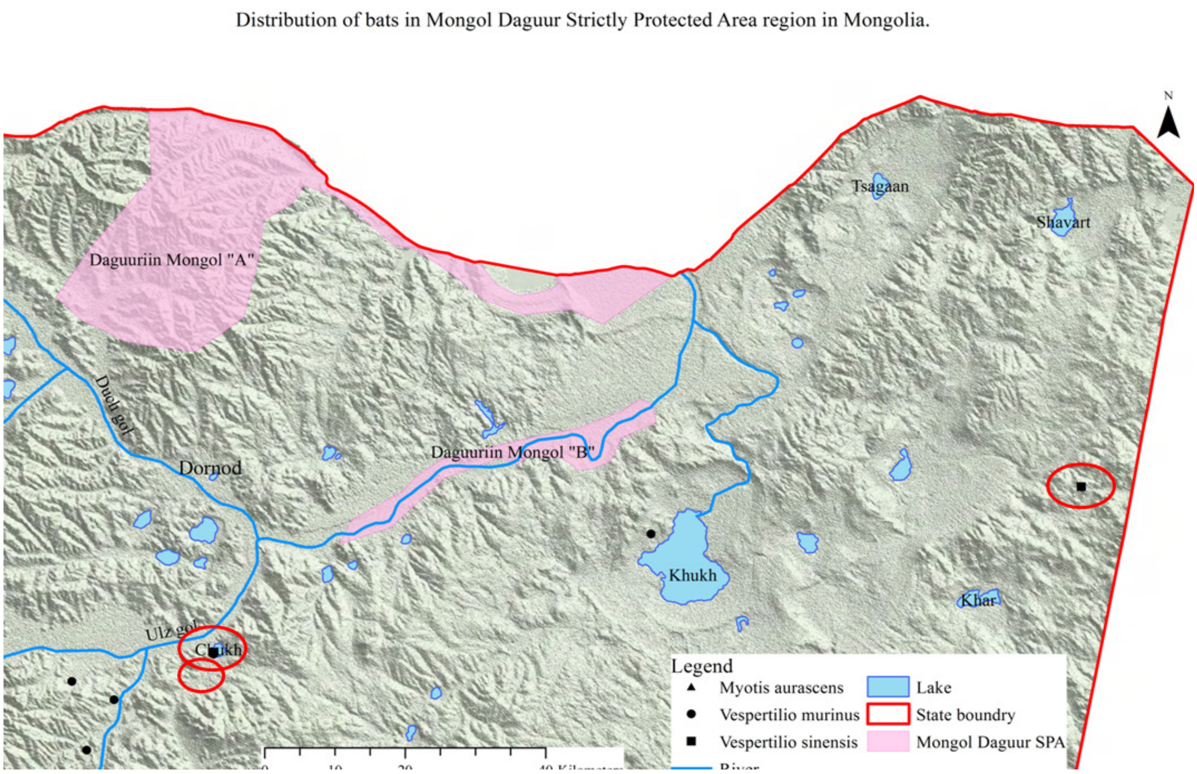


Figure 1. Map showing localities of study areas for the north-eastern Mongolia circled in red.

Abbreviations and Measurements.

Body measurements: Lbd = length of body; Lat = forearm length, LdIII = third digit length; LdV = fifth digit length; Ler = length of ear; Ltr = length of tragus. Cranial measurements: LCr = greatest length of skull; LCb = condylobasal length of skull; LaZ = zygomatic width; LaInf = width between foramina infraorbitalia; LaI = width of interorbital constriction; LaN = neurocranium width; ANc = neurocranium height; CM^3 = length of upper teeth-row between CM^3; CM_3= length of upper teeth-row between CM_3. Nomenclature of the species followed Wilson & Reeder (2005).

Results

We captured and measured a total of 20 particolored bats and 1 Asian particolored bat during the 3 year study period in Eastern Mongolia. Of these 20 particolored bats captured, 7 individuals captured Dun Lake and 13 individuals captured in Chukh Lake. We captured only 1 individual of Asian particolored bat in Targan Ukhaa Border Post in the Mongol Daguur Strictly Protected Area. Morphological measurements of particolored bats are shown in Table 1.

Particolored bat

Particolored bat is distributed in the Daurian forest steppe and Mongolian-Manchurian grassland in Daurian Steppe; Selenge-Orkhon forest steppe in Khangai; sub-boreal mixed forest and valley of (closed) lakes in Altay-Sayan; Eastern Gobi Desert steppe, Gobi Lakes Valley desert steppe and Dzungarian Basin semi desert in Central Asian Gobi Desert ecoregions in Mongolia. North-eastern edge of the species occurs in Khukh Lake and Chukh Lake region that Mongol Daguur SPA buffer zone (Figure 1). We found biggest colony of these species in buildings of Dun and Chukh Lake resort. We found colony of *Vespertilio murinus* from wall buildings in Dun lake and from roof in Chukh Lake (Figure 2a,b).

Asian particolored bat

Asian particolored bat distributed in the eastern Mongolia and Middle Khalkha in Daurian Steppe; Eastern Gobi Desert steppe in Central Asian Gobi Desert ecoregions in Mongolia. North-eastern edge of the species occurs in Targan Ukhaa Border Post that near to the China and Russia international border (Figure 1). We found colony of Asian particolored bat from the roof in buildings in Targan Ukhaa Border Post (Figure 3a,b).

Figure 2a. Habitat picture of *Vespertilio murinus* in Chukh Lake resort. Buildings of Chukh Lake resort. Photo by J.Ariunbold

Figure 3a. Habitat of *Vespertilio sinensis* in Targan Ukhaa Border Post. Photo by D. Munkhnast

Figure 2b. Colony of *Vespertilio murinus* in the roof of buildings in Chukh Lake resort. Photo by D. Munkhnast

Figure 3b. Colony of *Vespertilio sinensis* in the roof of buildings in Targan Ukhaa Border Post. Photo by D. Munkhnast

Discussions

We found largest colony of Particolored bat and Asian particolored bat occurs in Dun lake, Chukh Lake and Targan Ukhaa Border Post in the north-eastern also in Buir Lake in the eastern Mongolia. Our study shows the north-eastern edge of the distribution of Particolored bat and Asian particolored bats. These species make mixed colonies and inhabits close to the human residence in the steppe area. Therefore, humans still destroy them without knowing the significance of the bats. It is one of the known threats for bats in the steppe area in Mongolia. This problem requires public awareness for local people in the study area. Also this study indicates the importance for the conservation and understanding of bat species in the north-eastern and eastern Mongolia including Chukh Lake, Buir lake and Targan Ukhaa Border Post. We determined also position of bats in roost (could be cluster) and transitional (or swarming) site in the study area. The scientists of Mongolian-German biological expeditions recorded the three species in Chukh Lake in 2008. They studied genetic variation within Mongolian vespertilionid bats including the eastern and north-eastern steppe in Mongolia (Datzmann et al. 2012). At present, the occurrence of three species (*Myotis aurascens*, *Vespertilio murinus* and *Vespertilio sinensis*) is well confirmed in Chukh Lake and required a detailed survey of bats using a combined applications of both the traditional and new research methods in the steppe area in Mongolia in the future.

References

Allen, G.M. 1938. *The Mammals of China and Mongolia.* American Museum of Natural History, New York. Part I.

Ariunbold, J. 2011. Taxonomy of bats (Chiroptera: Vespertilionidae) in Mongolia. *Proceedings of Institute of Biology*, 28: 220-225. (in Mongolian)

Bannikov, A.G. 1954. *The Mammals of the Mongolian People's Republic.* Academy of Sciences, Moscow, (in Russian).

Clark, E. L., Munkhbat, J., Dulamtseren, S., Baillie, J.E., Batsaikhan, N., Samiya, R. & Stubbe, M. 2006. *Mongolian Red List of Mammals.* Zoological Society of London. Ulaanbaatar, ADMON Printing.

Dulamtseren, S. 1970. *Guide to the Mammals of Mongolia.* Mongolian Academy of Scienses, Ulaanbaatar, (Mongolian).

Dolch, D., Batsaikhan, N., Thiele, K., Burger, F., Scheffler, I., Kiefer, A., Mayer, F., Samjaa, R., Stubbe, A., Stubbe, M., Krall, L. & Steinhauser, D. 2007.Contributions to the Chiroptera of Mongolia with first evidences on species communities and ecological niches. Erforsch. Biol. Ress. Mongolei 10: 407-458. Halle/Saale.

Datzmann, T., Dolch, D., Batsaikhan, N., Kiefer, A., Helbig-Bonitz, M., Zophel, U., Stubbe, M., & Mayer, F. 2012. *Cryptic diversity in Mongolian vespertilionid bats (Vespertilionidae, Chiroptera, Mammalia).* Results of the Mongolian-German biological expeditions since 1962, No.299. *Acta Chiropterologica*, 14: 243-264.

Lebedev, V.S., Bannikova, A.A. & Surov, A.V. 2010. *Mammal species of Mongolia: News for the last 30 years.* Ecological consequences of Biosphere processes in the Ecotone zone of southern siberia and central Asia. Proceedings of the international conference, Vol 1. Ulaanbaatar, Mongolia.

Mallon, D.P. 1985. The mammals of the Mongolian People's Republic. *Mammal Review*, 15: 71-102.

Nyambayar, B., Ariunbold, J. & Sukhchuluun, G. 2010. A contribution to the bats inhabiting arid steppe habitats in central Mongolia. Erforsch. Biol. Ress. Mongolei. 11: 329-340. Halle/Saale

Sokolov, V.E. & Orlov, V.N. 1980. *Identification guide to the mammals of Mongolia.*Nauka Press, Moscow, (Russian).

Stubbe, M. & Chotolchu, N. 1968. *ZurSaugetierfauna der Mongolei.* Mitteilungenaus dem Zoologischen Museum Berlin, 44: 5-121.

Wilson, D.E. & Reeder, D.M. 2005. Mammal Species of the World: A taxonomic and Geographic Reference. 3rd Edition. The Johns Hopkins University Press, Baltimore.

Table 1. Morphological measurements of Particolored bats (*Vespertilio murinus*) captured in Eastern Mongolia

Measurements	Mean ± SD	Min	Max	N
LCr	15.4 ± 0.9	14.4	17.7	18
LCb	15.0 ± 0.7	13.8	16.7	18
LaZ	9.3 ± 1.0	7.4	11.0	18
LaInf	4.3 ± 0.1	4.1	4.5	18
LaI	7.7 ± 0.2	7.2	8.1	18
LaN	8.8 ± 0.4	8.2	9.6	18
ANc	6.7 ± 0.4	6.0	7.4	18
CM^3	5.4 ± 0.4	4.8	6.5	18
CM_3	6.0 ± 0.5	5.4	6.9	18
Lbd	55.9 ± 3.7	47.3	60.2	20
Lat	44.2 ± 2.0	41.3	48.8	20
LdIII	65.6 ± 4.5	56.6	75.7	20
LdV	46.5 ± 2.7	38.5	51.0	20
Ler	10.1 ± 1.1	8.2	12.4	20
Ltr	3.6 ± 0.3	3.0	4.2	20

Data About Population Dynamics of Cranes and Geese in *Dalai Lake* and *Huaihe* Nature Reserves (Inner Mongolia, China)

O.A. Goroshko[1,2], Liu Songtao[3]

[1] *Daursky State Nature Biosphere Reserve, Russia* oleggoroshko@mail.ru
[2] *Chita Institute of Nature Resources, Ecology and Cryology, Russia*
[3] *Dalai Lake National Nature Biosphere Reserve, China*

Abstract*:* The study area is located in the transboundary Russian-Chinese-Mongolian Dauria steppe ecological region. We undertook our study in July of 2004 and 2011, at *Dalai Lake* and *Huaihe* National Nature Reserves, both of these are globally important habitats for waterbirds in the north of Inner Mongolia, China. Data on population size and dynamics of red-crowned crane, white-naped crane, Eurasian crane, Hooded crane, Demoiselle crane, swan goose, and Greylag goose are presented. Dynamics of numbers of the populations is closely connected with long-term climatic changes.

Keywords: *Dauria, cranes, geese, Anser cygnoides, Grus vipio, Grus japonensis*

Introduction

The Dauria steppe is an extremely important region of summer habitation for rare species of cranes and geese, however data on their distribution, population size and the state of the populations in this region is very limited, especially within China. This article presents some results from the joint work of the *Daursky* Reserve (Russia) and the *Dalai Lake* Reserve (China). The survey from parts of the Chinese Dauria are the most important ornithologically, and also the analysis of the observed changes in the state of the birds' populations and their habitats.

The Daurian transboundary ecoregion (hereafter, Dauria) covers the steppe of Dauria-Mongolian type in South-East Transbaikalia, North-East Mongolia and North-East China. Besides the well-preserved vast steppes, of enormous importance in Dauria are broad swampy river valleys and hundreds of lakes, which form a complicated network of wetlands with a very high level of biological diversity. Dauria is one of the most important areas in East Asia for nesting and passage of birds including globally endangered species. The area plays an important role in the worldwide conservation of a number of crane and geese species. In particular, more than half the world population of Swan geese (*Anser cygnoides*) inhabit Dauria, and important nesting and molting habitat is found here. Much rarer on nesting and moulting is Greylag goose (*A. anser).* In the Dauria six species of cranes can be found. It is an important nesting area for Demoiselle cranes (*Anthropoides virgo*), white-naped (*Grus vipio*) and red-crowned (*G. japonensis*) cranes. Eurasian cranes *(G. grus)* are also found in small numbers. Hooded cranes (*G. monacha*) and Siberian cranes (*G. leucogeranus*) are found only during their migration period. In summer time groups of non-nesting, mainly immature, individuals of all the above mentioned species of geese and crane also use this area for habitat.

All the parts of Dauria are closely linked to each other. The region has a constant circulation and re-distribution of bird and animal populations, which change and move depending on the season, time of year, multi-year climatic changes and other circumstances. Therefore it is impossible to conserve the wildlife, especially birds, in Dauria, as well as in other similar transboundary ecoregions, without close international cooperation. The Dauria International Protected Area (hereafter, DIPA) plays a leading role in the study and conservation of biological diversity across the vast Daurian ecoregion.

Methods

Study area

We conducted our study within and beyond the Daurian transboundary ecoregion (hereafter, Dauria). The largest water body in Dauria is Lake Dalainor (approximately 90 x 27 km, the centre of the lake is about N 49°00', E 117°30'). The largest and the most ornithologically significant river in the Chinese Dauria is the Hailar-Argun (China, Russia). The *Dalai Lake* Reserve includes, in addition to Lake Dalainor, Lake Ulan-Nur, a much smaller but extremely important lake as a habitat for waterfowl (the size of the lake is approximately 15 x 2 km, the centre of the lake is N 48°19', E 117°27'). It is also an important nesting and molting area for geese.

A key nesting area for red-crowned cranes and swan geese is the spacious swampy floodplains of the Huaihe River (a secondary tributary of the Hailar-Argun). Habitat suitable for geese and cranes are located in the middle and lower reaches of the river (appr. from N 48°53', E 119°37' up to N 48°10', E 119°16'). This is within the territory of another reserve under national protection – the *Huaihe*. There the floodplain is very broad (up to 15 km), swampy, includes lots of small lakes, and the river splits into numerous arms. The size of the entire area is approximately 100 x 10 km, and the size of the most swampy northern part of the area studied by us is about 65 x 10 km with the centre approximately in the point N 48°44', E 118°55'. The area is poorly studied.

Of huge influence on the state of the steppe ecosystems in the Dauria are climatic cycles that last for about 30 years. Alternating long-term periods of drought and wet climate occur, causing fluctuations in water content and level of rivers and steppe lakes. This results in fundamental transformations in bird habitat and in turn, in their populations (especially waterfowl and shore bird species). The last peak drought period was in 1983, and of a wet period from 1995-1998. Since 1999 the amount of precipitation has been decreasing. Extreme drought years occurred 2000-2008 and the first half of the year 2009. Somewhat wetter was the second half of the year 2009 and also the years 2010 and 2011. By 2007-2009 in the Daurian steppe around 98% of small and middle-sized lakes, springs and rivers had dried out, that caused a sharp deficit in habitats for cranes and geese (Goroshko, 2011a, c; Goroshko and Tseveenmyadag, 2003).

Survey methods

Our first a joint census in the *Dalai Lake* Reserve was conducted in August 2002 (Goroshko, Liu Songtao, 2003). At that time the basic habitat of geese and crane were identified and enabled us to plan an effective summer census. In the Dauria the optimum period for a summer census of geese is July. By that month hatching is finished, and on the lakes all families with chicks move to the open (without reed) parts of the shore. The birds that do not participate in nesting are moulting in July. All non-breeding geese gather from the Dauria on several lakes suitable for molting. There they stay in dense flocks on the open water. July is also a suitable time to census nesting cranes, as at this time effective counting of chicks is possible because they are already sufficiently large to be seen.

On the lakes we counted breeding geese families using the methods described in our previous paper (Goroshko, 2001). We counted birds along the shore with the use of a car, binoculars (8X) and a field glass (25-75X). We tried to examine the entire shoreline of a water body, to ensure all birds were recorded. Non-breeding birds were counted during detailed observations of the water area and the shoreline from nearby hills with the help of a field glass. To do this we made a series of stops on route around each lake.

To count geese and cranes on swampy sites in the floodplains of rivers we used a similar method (Goroshko and Tseveenmyadag, 2001). We plotted the car route along the edge of the valley, so that the floodplain could be seen clearly. We conducted a bird census every 2-8 km along the route, and undertook detailed observations of the floodplain from high points (if there were no high points, the top of the car was used) with the help of binoculars and a field glass. The distance between stops depended on conditions for viewing the area and was set so that the entire area of the floodplain could be observed. We also recorded the state of the sites (degree of water content, composition and condition of vegetation), and noted all the threats and disturbing factors (traces of fires, presence of humans and livestock in the floodplain, etc).

The very broad floodplain of the Huaihe overgrown with high reed, as well as shallow waters in the north-eastern part of the Ulan-Nur, are difficult for ground-based census of birds, as in many cases they are not clearly viewed from the flanks of the valley. Tall plants hide the birds, and the hills fringing the valley are not high enough to view all the broad floodplain clearly from them. Along with this, the rate of uncounted birds is much larger among relatively short geese than among cranes. According to our estimations the rate of uncounted birds can amount to 30% with cranes and 60% with geese.

We examined Lakes Dalainor and Ulan-Nur in 2004 in the period of July 14-18. We drove almost completely around Lake Dalainor, and observed about 80% of its shoreline and the near-shore water area including all potentially suitable habitat. This included the mouth of the Kherlen, the southern and north-eastern swampy sections of the lake, and also around 70% of the large shallow Lake New Dalainor (located in the north-eastern part of the Dalainor and joins it when the water level is high). In the surrounding areas of the Dalainor we observed 9 small steppe lakes.

In 2011 we conducted census in the *Dalai Lake* reserve in the period from the 22nd to the 24th of July. At that time we observed on the Dalainor only the south-western and southern parts of the lake including the mouth of the Kherlen. The rest of the lake was not observed because of its low suitability for habitation of geese and cranes due to the great drying of the lake. Besides, in 2011 we observed 13 small steppe lakes in the environs of the Dalainor. Lake Ulan-Nur was observed entirely both in 2004 and 2011, by driving around the whole lake along its shoreline. Such relatively complete census of geese and cranes on the Ulan-Nur was conducted by us in 2004 for the first time.

Observation on the Huaihe River was made in July 21-23, 2004 and in July 26-27, 2011. The census work in 2011 due to unfavorable weather conditions was far less complete than in 2004. In 2004 we observed the valley from the lower (northern) edge of spates (from the point N 48°49,2'; E 119°13,3') along the western (left) edge of the valley up the stream to the point N 48°26,1', E 119°08' and then along the eastern edge of the valley from the lower end of spates up the stream to the point N 48°42,2', E 118°48,7'. We examined a little more than a half of the swampy sites on the Huaihe - only their northern part (the spates stretch up the stream to the point N 48°10', E 119°16'). In 2011 we examined the valley only along its western edge from the lowest point N 48°50'; E 119°12,4' up the stream to the point N 48°44,6', E 118°47,9'.

Results and discussion

Of all cranes nesting in the Dauria, red-crowned cranes prefer the most swampy sites. They inhabit wet areas and the flooded shallow water floodplain sites, where spacious sedge-blue joint meadows intersperse with reed stands. The most compatible with these requirements in the Dauria in the wet years is the broad floodplain of the Argun river in its upper part (6-10 km wide) and the spates up to 15 km wide in the lower part of the Huaihe. By the end of the drought period of the 2000s the floodplain of the Argun had dried out by 95% and had lost its importance as a habitat of red-crowned cranes (Goroshko, 2008, 2011b). The hydrological regime of the Huaihe is more stable than that of the Argun. In 2004 there were spacious reed, grass, and sedge swampy meadows there with a large number of small lakes and ponds. By 2011 wetlands on the Huaihe had dried a little, nevertheless, rather spacious swampy parts still remained.

White-naped and Eurasian cranes also inhabit swampy sites but, unlike Red-crowned cranes, they prefer less swampy areas - wet sedge and grass meadows near reed stands. Demoiselle cranes nest on dry steppe sites near water bodies and other water sources.

Greylag geese prefer much more swampy sites than swan geese. Greylag geese nest in swampy reed stands with water pools. Nestlings keep to adjacent grass meadows. Swan geese prefer to nest on islands covered with steppe vegetation, they can nest on the boundary between stands of dry and wet reed, in high steppe shoreline plants. Broods of swan geese feed on grass and sedge meadows. On lakes juvenile swan geese usually stay at shorelines with steppe vegetation, in case of danger they go to the water.

The most part of Lake Dalainor is not suitable habitat for swan geese, greylag geese and cranes (except for Demoiselle crane). The shores of this water body are mainly stony and sandy; there is almost no aquatic and semi-aquatic vegetation. Only the southern and north-eastern parts of the lake had swampy sites, reed stands and sedge-grass meadows during the wet period of the 1990s. At that time nesting of geese was possible, however, in 2002 it became unlikely due to a great fall of water level in the lake and reliction from the stands line at 100-200 m (Goroshko and Liu Songtao, 2003). By 2004 the reeds and sedge meadows were separated from the water by a belt of bare ground, with no plants, sandy beaches 80 to 1,100 m wide. By 2011 the reed stands had disappeared nearly altogether, and the width of the bare beaches in most cases was more than a kilometer. Because of this, the lake became unsuitable for nesting of geese, as the places for feeding chicks - grassy and sedge meadows - became unavailable due to their remoteness from water.

The large shallow Lake New Dalainor has brackish water, flat open shores where thin sedge spring is found on the spacious muddy shoals. In the lake there are large underwater meadows of fennel-leaved pondweed (*Potamogeton pectinatus*) – one of the most important forage plants for swan geese (Goroshko, 2001). The conditions there are not suitable for geese nesting, as there are no islands and shelters on the shore to build nests, besides, sedge meadows do not provide the right habitat. However, this water body, thanks to rich stocks of fennel-leaved pondweed, sometimes provides suitable habitat for non-breeding birds, especially during migration. In 2002 the channel joining the New Dalainor and the Dalainor was dried-out. In 2004 the New Dalainor was very shallow, its area had decreased greatly. Then the lake dried out completely.

The most suitable area for swan geese breeding is Lake Ulan-Nur. Its hydrological regime is far more stable than that of Lake Dalainor. The Ulan-Nur has an elongate form. The north-western shore is flat and it joins steppe vegetation; the width of the exposed lake bed n 2002 was about 6 m. The south-eastern shore is mainly swampy, there are vast reed stands, as well as underwater fennel-leaved pondweed meadows. At the north-eastern and south-western edges of the Ulan-Nur there were vast reed shallow waters till 2004. By 2011 the water level in Lake Ulan-Nur had somewhat fallen. In 2011 the shallow waters in the north-eastern part remained, and in the south-western part they decreased significantly. The width of the bare shore belt along the non-swampy part of the Ulan-Nur even in 2011 was only some tens of meters, that enabled broods of Swan Geese to inhabit the area. Therefore, the Ulan-Nur even in 2011 did not lose its significance as a nesting area for geese, although conditions of their habitation became somewhat reduced.

The results of the census in *Dalai Lake* Reserve are shown in Table 1. On Lake Dalainor and the adjacent small lakes a small part of the population was counted: in 2004 - 23 non-breeding individuals and 3 families with 11 chicks of swan geese, and also 11 non-breeding birds and 3 families with 5 chicks of Demoiselle cranes; in 2011 - 18 non-breeding swan geese, 1 non-breeding greylag goose and 4 non-breeding Demoiselle cranes. On Lake New Dalainor in 2004 only 2 non-breeding swan geese were recorded. So, nearly all geese and cranes recorded in July, in *Lake Dalainor* Reserve, were found in Lake Ulan-Nur.

In 2004 on Lake Ulan-Nur 40 broods of swan geese were registered, the broods included 136 chicks, and also a large number of non-breeding moulting birds - in total 2,451 individuals, 2,380 of those belonged to one flock in the south-western part of the lake. Before that it was unknown that swan geese were found on the Ulan-Nur in such large numbers and that they moult there. It was unknown that they nest on at this lake. In 2011 on the Ulan-Nur 35 broods were counted, which included 106 chicks, and 2,516 non-breeding birds, the overwhelming majority of the latter were moulting, and unable to fly. Therefore, in 2011 on the Ulan-Nur there was some decrease not only in the numbers of nesting swan geese but also in the average size of broods (from 3.4 chicks in 2004 to 3.0 in 2011). This fact shows that the conditions for nesting had become worse, and particularly, the forage stock was poorer due to the drop in the water level of the lake and an increase in the distance from the water edge to the near-shore vegetation. Unlike 2004, in 2011 moulting birds were distributed more evenly - almost across the whole area of the lake in groups of ten to 850 individuals.

Among greylag geese on the Ulan-Nur in 2004 7 broods were registered including 28 chicks, in 2011 there were 6 broods (22 chicks). Thus, the numbers of nesting couples remained nearly the same, and the average size of a brood a little decreased (from 4.0 chicks in 2004 to 3.7 in 2011). As for the numbers of non-breeding birds, it increased nearly 10-fold (the overwhelming majority of those were molting in 2011). Probably, it is connected with the appearance of a large number of non-breeding birds because the conditions for nesting in other parts of the Dauria and the adjacent regions became much worse. Despite the census on the Huaihe in 2011 being less complete than in 2004, it enabled us to determine significant changes in the state of bird populations. For comparison it is more convenient to use the estimates of the numbers (Table 2).

The numbers of nesting couples of red-crowned cranes on the Huaihe has increased a little and the number of non-breeding birds has grown more than 2-fold. This occurred against a background of habitat deterioration at the Huaihe, which shows a great decline in habitat condition in the other parts of the Dauria; as a result the birds had to leave their habitats there. The numbers of nesting couples of red-crowned cranes on the Huaihe have slightly increased and the number of non-breeding birds has increased more than double. This occurred against a background of declining habitat condition in the other parts of the Dauria, as a result the birds had to leave their habitats there. This situation was particularly strong on the Argun, the floodplain of which has become nearly completely unsuitable for habitation by Red-crowned cranes in recent years (Goroshko, 2011b).

Even greater changes occurred in the population of white-naped cranes. The numbers of nesting couples increased approximately 7-fold. In 2011, 101 non-breeding birds were recorded, their numbers were estimated at approximately 400 individuals, though in 2004 no non-breeding birds were recorded. On the one hand, it shows a drastic decline in habitat condition in other parts of the Dauria - the birds have disappeared from many other areas in the region (Goroshko, 2011c). On the other hand, it shows that on the Huaihe relatively favorable conditions have formed as a result of the decrease in swamp habitat, which previously made it unsuitable for the species. This is supported by an increase in Eurasian cranes, and even nesting of six couples (before that breeding of this species was not registered there). The Eurasian crane, as well as the white-naped crane, prefers areas that are not swampy.

It is more difficult to understand what has happened in the geese populations on the Huaihe, as they are greatly influenced by natural climatic factors, but also by egg collection by humans, which is in practice in China. The number of swan geese, both nesting and non-breeding, has nearly halved, but the number of greylag geese has nearly doubled. Considering the swamp habitat of the area, which has decreased, this change would have been expected to be in reverse. Perhaps, egg collection has partly influenced the populations. We suspect that swan geese eggs are collected more often than those of greylag geese, as nests of swan geese are situated on relatively dry sites and therefore they are more easily accessible. There are data that the rate of egg collection in recent years is great. It therefore could have damaged the population of swan geese. It is not clear so far what has caused the increase in the numbers of greylag geese. This species rarely nests in the Dauria (it is far rarer than swan goose). It is therefore likely that the cause lies outside the Dauria, in other parts of the species range.

Acknowledgements

The authors express their gratitude to Bao Ler, Gerilechaoketu and Svetlana Balzhimayeva for the help in censuses and collecting the material. The work is fulfilled with the support of WWF.

References

Goroshko O.A., 2001. Swan Goose in east Transbaikalia and Mongolia. Brant goose. № 7. P. 68-98.

Goroshko O.A., 2008. Distribution and numbers of Red-crowned Crane in the Argun river valley. Cranes of Eurasia (biology, distribution, migrations). Issue 3. M.: Moscow Zoo. P. 159-173.

Goroshko O.A., 2011a. Influence of multi-year climatic cycles on ornithocomplexes of Dauria. Papers of the conference «Evolution of biogeochemical systems (factors, processes, regularities) and problems of nature-use (27-30.09.2011, Chita, Russia). Chita: Publishing house of Zabaikalsky State Humanitarian Pedagogical University. P. 140-143.

Goroshko O.A., 2011b. Investigation of the Argun river (Zabaikalsky krai) in 2009. Newsletter of Crane Working Group of Eurasia. № 11. P. 12-14.

Goroshko O.A., 2011c. State of white-naped cranes population in Dauria (south-east Transbaikalia and north-east Mongolia). Newsletter of Crane Working Group of Eurasia. № 11. P. 9-10.

Goroshko O.A., Liu Songtao, 2003. Numbers and main habitats of Swan Goose and Ruddy Shelduck in the *Dalainor* nature reserve (north-east China). Casarca. № 9. P. 372-376.

Goroshko O.A., Tseveenmyadag N., 2001. White-naped Crane in south-east Transbaikalia. Achievements and problems of ornithology in North Eurasia at the turn of the century: Papers of International conference «Topical issues of studying and protecting birds in East Europe and North Asia». Kazan: Magarif. P. 522-529.

Goroshko O.A., Tseveenmyadag N., 2003. Data on influence of droughts on white-naped cranes population. Terrestrial vertebrates of Dauria. Collection of scientific papers. Issue 3. Chita: Poisk publishers. P. 121-130.

Table 1. The counted and estimated number (with its confidence interval) of cranes and geese in Dalai Lake Nature Reserve in 2004 (14-18 July) and 2011 (22-24 July)

Species	Year	Number counted			Number estimated		
		adults	chicks	combined	adults	Chicks	combined
Red-crowned crane	2004	1	1	2	2	1-2	3-4
	2011	3	0	3	3	0	3
White-naped crane	2004	5	0	5	5	0	5
	2011	2	2	4	2	2	4
Eurasian crane	2004	0	0	0	0	0	0
	2011	1	0	1	1	0	1
Hooded crane	2004	0	0	0	0	0	0
	2011	1	0	1	1	0	1
Demoiselle crane	2004	38	5	43	94 (78-110)	12 (9-15)	106 (87-125)
	2011	16	2	18	45 (32-58)	5 (4-6)	50 (36-64)
Swan goose	2004	2562	147	2709	2615 (2360-2870)	159 (147-170)	2774 (2507-3040)
	2011	2605	106	2711	2730 (2600-2860)	112 (106-118)	2842 (2705-2980)
Greylag goose	2004	56	28	84	67 (60-73)	33 (30-36)	100 (90-109)
	2011	571	22	593	600 (570-628)	23 (22-24)	623 (593-652)

Table 2. The counted and estimated number (with its confidence interval) of cranes and geese in Huihe Nature Reserve in 2004 (21-23 July) and 2011 (26-27 July)

Species	Year	Number counted			Number estimated		
		adults	chicks	Combined	adults	chicks	combined
Red-crowned crane	2004	42	10	52	72 (68-76)	16 (15-17)	88 (83-93)
	2011	54	6	60	190 (160-215)	21 (18-24)	210 (180-240)
White-naped crane	2004	6	3	9	8 (6-10)	5 (3-6)	13 (9-16)
	2011	117	10	127	410 (350-470)	35 (30-40)	445 (380-508)
Eurasian crane	2004	0	0	0	0	0	0
	2011	45	9	54	158 (135-180)	32 (27-36)	189 (162-216)
Hooded crane	2004	5	0	5	5	0	5
	2011	19	0	19	67 (57-76)	0	67 (57-76)
Demoiselle crane	2004	10	0	10	14 (12-16)	0	14 (12-16)
	2011	15	0	15	68 (60-75)	0	68 (60-75)
Swan goose	2004	424	530	954	773 (615-930)	968 (770-1165)	1740 (1385-2095)
	2011	65	100	165	358 (325-390)	550 (500-600)	908 (825-990)
Greylag goose	2004	301	154	455	630 (540-720)	323 (275-370)	953 (815-1090)
	2011	180	35	215	1283 (1115-1450)	720 (625-815)	2000 (1740-2260)

Birds of Hulunbuir Steppe, China

Liu Sontao[1], Li Xinhai[2], Gerilechaoketu[1], Wu Liji[1]

[1]*Dalai Lake National Nature Reserve Bureau, Hailaer, Inner Mongolia 021008, China*
[2]*Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China*

Abstract: Hulunbuir Steppe is located at the eastern edge of the Eurasia Steppe.It is a grassland ecosystem with the richest biodiversity in China. Generally, the support of European Union Steppe Biodiversity Conservation and Sustainable Management Project, Dalai Lake National Nature Reserve conducted field investigations in spring, summer and autumn in 2008 and 2009, and summarized the investigation data of 2006 and 2007.This report summarizes the distribution and number of birds observed for 14 orders, 32 families and 167 species of birds, observed between 2006 and 2009 in the Hulunbuir steppe study area.

The majority of birds observed were water birds or steppe birds. The rivers and lake-wetland ecosystems originating from Erguna River are important migratory stop over sites for water birds. More than 120 water bird species have been recorded in this area, one third of all bird species in this area. Most of the typical steppe birds can be found where the steppe ecosystem remains relatively unharmed. We recorded more than 120 species of Passeriformes in the study area.

Introduction

Hulunbuir Steppe (see Figure 1) is located in the west Great Khyangan, Northeast of China. The zonal vegetation of this area is typical steppe, the north and east part of this area is meadow steppe; the middle part of this area is the source water system of Erguna river. The various kinds of wetland ecosystem originated from Dalai Lake, Hailaar River and Gen River, together with the wild animals and plants inhabit in this area compose the rich biodiversity of Hulunbuir Steppe.

The Transbaikalia Steppe of ZabaikalskKrais in Russian Federation and the Hulunbuir Steppe of Hulunbuir City in Inner Mongolia of China compose one part of the boundary line, this part is the important component of Mongol-Daurian Steppe (it is also called Daurian Steppe Ecoregion) of Central Asia in Eurasian Steppes.

Hulunbuir Steppe is one part of the Mongolian plateau prairie province geographically. Mongolian plateau prairie province is an ancient plant geographical region of the Eurasia Steppe Central Asia sub-region; it is also called Dauria Mongolian Province or Mongolian Steppe Region in the related literature of the former Soviet Union Plant Ecology and Botany.The northern scope of this province includes the mountain forest steppe region of Tang's Ural mountain, the nearby places of Subuguertai and Khentii Mountains, the region from Transbaikalia steppe region of the upper reaches of Selenga River to the Hulunbuir steppe region of the upper reaches of Heilong River; the eastern boundary of this province adjacent to Great Khyangan mountainous coniferous forests region; the southeast part of this province adjacent to the Mountain Forest Grassland State in the southern part of Great Khyangan; the southern part of this province adjacent to Loess Plateau Steppe province with the Yinshan mountains as their watershed; the western part of this province adjacent to the desert region in middle Asia. On the whole, this province located in the middle of the Eurasia Coniferous forest and the East Asia Summer green broadleaf forest region to middle Asian desert region. Our monitoring area is the east steppe region of Mongol and the Hulunbuir steppe of China belong to the Mongolian plateau grassland plant region (CAS, 1985. p.405).

This region is mostly occupied by high plains, which are wide, flat, varied in a wave shape. Some parts are occupied by rocky hills, plateaus, deserts and river valleys. (CAS, 1985. p.407). Moreover, the study area is rich in surface water including the Erguna River, Gen River, Hailaar River, Moergele River, Yimin River, Hui River and Kherlen River, which all belong to the Erguna river system.

Materials and Methods

Bird investigation mainly focuses on the fauna component, population quantity, distribution and behavior characteristics. We used different investigation methods for different groups of birds. Eu- China Biodiversity Program (ECBP) used the line transects method and point interpolation method (Sutherland 1996) for bird investigation in Dalai Lake National Nature Reserve.

Water birds investigation - belt and line transect methods

Every spring, summer and autumn, we conducted water birdinvestigations on the whole Hulunbuir steppe region along the 33 fixed sample lines. Each line was about 50 kilometers long. The sample lines were designed by Hulunbuir steppe biodiversity and sustainable utilization project. We used binoculars and cameras to observe and used a counter to count individuals. For groups of birds greater than 100 or for birds in motion (e.g., flying), we estimated categorical group size. We used 10, 20, 50 or a larger number as one counting unit instead of counting every single bird. During this investigation, we recorded the water birds in Dalai Lake Reserve; middle part of Hui River Reserve, middle reaches area of Erguna River and Erka Wetland in detail.

Grassland bird investigation - point interpolation methods

Individuals of grassland birds are relatively smaller than water birds, and they act according to some daily rhythm and seasonal cycles. We investigated grassland birds mainly in the morning and at dusk. We choose the point count stop(the stop for counting birds) randomly, and counted birds for 5 minutes (after 2 minutes of preparation). The spacing between the stops was about 500 meters.

Forest-grassland ecotone birds method

Birds in Forest-grassland ecotone are a very complex fauna. We consulted the point interpolation method (Bart 2005; Tozer et al. 2006), investigating birds in the morning and at dusk. We identified birds mainly by their calls.

Investigation Process

Dalai Lake Reserve staff mainly conduct investigation on water birds and raptorial birds in 2006 and 2007, the investigation regions include Dalai Lake, Hui River, Erguna River, Hulieyetu, Erka and Huhenuoer, the investigation time mainly focus on spring and autumn. From 2008 to 2009, Dalai Lake Reserve conducted line transects investigation in spring, summer and autumn according to the Europe China Biodiversity Program (ECBP). Investigation in spring mainly conducted from April to May. Investigation in summer mainly conducted in July, but the summer investigation in 2009 lasted for a relatively long time for 74 days, from 17th June to 30th August. Investigation in autumn mainly conducted from September to October.

In this program, Dalai Lake Reserve also investigated grassland birds, including grassland singing birds such as Lark and some forest-grassland ecotone birds. In 2008, Dalai Lake Reserve finished investigation work of 28 sample lines, and finished investigation work of 33 sample lines in 2009. In four years, we covered 50,000 kilometers.

Investigation Time

Investigation in spring mainly conducted from April to May. Investigation in summer mainly conducted in July, but the summer investigation in 2009 lasted for a relatively long time for 74 days, from 17th June to 30th August. Investigation in autumn mainly conducted from September to October.

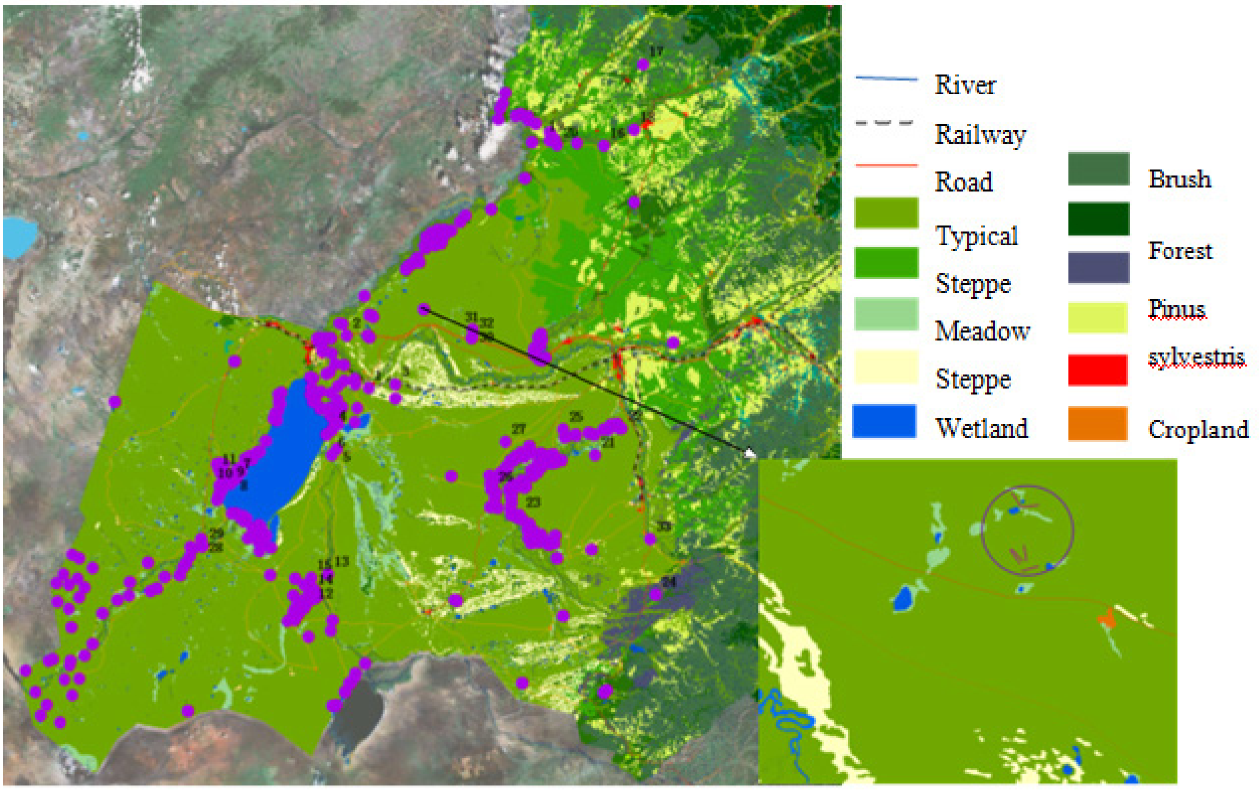


Figure 1. Locations of the Bird Investigation Points in Hulunbuir Steppe. The purple points in the left chart are the investigation points. The purple lines in the right chart are the investigation lines.

Results

From 2004 to 2009, we recorded 167 species of birds of more than 470400 individuals. These records summarized investigation results of water birds and raptorial birds in spring and autumn from 2006 to 2007. It also summarized investigation results of water birds, raptorial birds and grassland birds in spring, summer and autumn from 2008 to 2009.

Threatened and Protected birds

We observed and recorded seven species of China National First-level protected birds, and 28 species of National Second-level protected birds (See the Appendix I: birds list).

Birds monitoring in Hulunbuir Steppe mainly focusedmainly on water birds and from 2006 and 2007 only water birds and raptors were recorded. Thus, the Anseriformes occupy the largest proportion of records in this study (See Table 1). There were also thousands of grassland birds, such as Horned Larks, Skylarks, Mongolian Larks, we usually could record thousands. The spring bird investigation was conducted from 15th April to 1st May. This period is the peak time for migration of Anatidae, while the migration of shorebirds has just started. Consequently, most of our records are for Anatidae.

Table 1. Most common bird species recorded in Hulunbuir Steppe during 2006 - 2009

Latin Name	Number of Individuals Recorded	Latin Name	Number of IndividualsRecorded
Podiceps cristatus	2,126	*Anas acuta*	14,053
Phalacrocorax carbo	9,622	*Bucepha laclangula*	10,042
Ardea cinerea	1,549	*Aythya ferina*	73,257
Platalea leucorodia	1,150	*Aythya fuligula*	17,229
Cygnus columbianus	14,130	*Mergus albellus*	2,051
Cygnus cygnus	3,741	*Larus argentatus*	12,808
Anser cygnoides	11,126	*Larus ridibundus*	20,178
Anser anser	5,973	*Larus canus*	3,864
Anser fabalis	14,178	*Vanel lusvanellus*	6,694
Tadorna ferruginea	3,994	*Charadrius alexandrines*	2,388
Tadorna tadorna	8,156	*Limosa limosa*	2,360
Anasstrepera	85,756	*Tringa stagnatilis*	2,072
Anas crecca	57,173	*Calidris temminckii*	1,160
Anas platyrhunchos	43,814	*Fulica atra*	2,095
Anas penelope	30,792	*Eremophila alpestris*	2,084
Anas clypeata	5,279	*Emberiza pallasi*	1,600
Anas falcata	1,541		

Discussions

The bird investigation on Hulunbuir Steppe from 2006 to 2009 almost covered almost all the wetland of this area, and showed the composition and amount of water birds in this area. Migratory birds and breeding birds are the most important part of the water birds on Hulunbuir Steppe. This area is an very important transfer station of the East Asia-Australia migratory route, and every year millions of Anatidae and Shorebirds pass by. Because we didn’t invest in the whole spring and autumn migratory term, so what we have recorded is only a small part. But we have basically mastered all the composition and amount of water birds distribute in Hulunbuir Steppe according to the 4-years investigation from 2006 to 2009. Moreover, there are also a great number of raptorial birds and larks in Hulunbuir Steppe.

Migration Patterns and Seasonal Distribution of Grassland Birds in Hulunbuir Steppe

Spring

Birds of spring in Hulunbuir Steppe are mainly migratory birds. March to the middle of May is the time period for migration of birds on Hulunbuir Steppe. Migratory birds begin to come starting 26th to 28th March, European Herring Gull, Sea Gull and Grey Heron are the first to come, and the lakes and rivers are still frozen at this time. In April, the edge of the lake begins to thaw, the Anatidae come and we could see Mute Swan on the ice. The cranes begin to come in late April. Come into May, most of the lakes and rivers have thawed, and numbers of diving ducks and shorebirds come. The birds that come in groups are Sea Gull, Black-headed Gull, Swans (Mute Swan,Whooper Swan, and Tundra Swan), Swan Goose, Grey Goose, Cormorant, Anatine (Anas and Diving Duck), Cranes (Grey Crane, White-head Crane, and White-naped Crane) and some Shorebirds. The amount of birds in spring is great; at one point 17 million were recorded. Except for water birds, some other birds such as Willow Warbler, Robin, Muscicapidae, Finches and Raptorial Birds also come as the weather get warmer. Most of the migratory birds come to Hulunbuir Steppe grow to summer resident birds. Some of the migratory birds just have a rest and replenish energy in here and fly to Siberia, Russia or Arctic Region for breeding and become to passing migrant bird, such as Tundra Swan, most of Dunlin, White Crane, White-head Crane, Bias Crane and Bean Goose. Most of the birds are breeding here and will also migrate towards north and become a part of passing migrant birds.

In spring, birds live in Hulunbuir Steppe over the winter will go back to their breeding place in the north when the weather get warmer. They are winter resident birds, such as Gyrfalcon, Common Redpoll, Rough-legged Buzzard, Snow Bunting and Snowy Owl.

Summer

The breeding birds including resident birds and summer resident birds are the main parts of summer birds in Hulunbuir Steppe. Golden eagle, upland buzzard, Mongolian lark, skylark, oenanthe, red-crowned crane, white-naped crane, Demoiselle crane, mute swan, whooper swan, swan goose, grey goose, and Ciconiiformes, Ardeidae, Subgenera, Shorebirds, Laridae and other kinds of birds all breed here. The vast Hulunbuir Steppe and large area of wetland provide the breeding birds with favourable habitat, and this area become important breeding place for some endangered birds such as Red-crowned Crane, White-naped Crane, Great Bustard, Steppe Eagle, Mute Swan and Swan Goose. In summer, there are also some birds that do not participate in breeding wandering in the steppe and wetland, like White-head Crane and White Crane wander in dozen (1986 to 1987). All this show the bird fauna distribution characteristics of Hulunbuir Steppe as the inland draught steppe.

Autumn

In late July, Hulunbuir Steppe enters the autumn migratory season, the Shorebirds that go north latest will come first, and Anatidae will follow. These birds that are migrating south will meet the birds breeding here and continue go south after replenish energy. In autumn, some birds like Swan,Whimbrel, Anatidae, Starling, Dunlin, Godwit, Lapwing, Shorebirds and Cranes wander in large groups. Laridae is the last migratory birds in Hulunbuir Steppe, they do not leave until the rivers and lakes are completely frozen at the end of October. As the passing migrant birds and summer resident birds leave, winter resident birds come to Hulunbuir Steppe, and they will pass the winter in here and go back to the northeast next spring when the migratory birds come back to the Steppe. They will come again and again, and migrate every year.

Spatial Distribution of Birds on Hulunbuir Steppe

The ecological environment type of Hulunbuir Steppe could divide into five types: they are forests and grassland ecotone, meadow steppe, typical steppe, sand and wetland. We describe the birds respectively with the species distribution characteristics and habitat type according to their different habitat environment. Birds distributing in meadow steppe and typical steppe are very similar, so we add the birds of these two types together. Although the sand of Hulunbuir is widely distributed, it is ordinarily stripe-shaped, and does not form some special distribution characteristics, so we also added the birds in this sand area into the grassland ecosystem to discuss.

Forests and Grassland Ecotone

Birds in this area not only have the characteristics of forest birds and grassland birds. Some typical forest birds like Great Spotted Woodpecker,White-backed Woodpecker, Great Tit, Long-tailed Tit, Yellow-breasted Bunting, Willow Tit and Eurasian Jay. And some Meadow Bunting, Red-throated Thrush and Little Bunting also appear in this area.

Steppe area (including typical steppe, meadow steppe and sand)

The dry climate and single landscape make the birds distributed in this area show the important characteristics of Hulunbuir bird fauna. Grassland singing birds like Mongolian Lark, Skylark, Horned Lark, Red-capped Lark, Oenanthe and Isabelline Wheatear are the dominant species of this ecological environment. Upland Buzzard, Golden Eagle and Steppe Eagle breed on relatively high altitude in the mountainous region. Oriental Plover, Eurasian Eagle Owl, Demoiselle Crane and Great Bustard all breed in the grassland. Grassland is the main habitat for the resident birds of this area. Some wetland birds like Black-headed Gull, Northern Lapwing, Little Curlew and White-winged Tern sometimes also forage in the grassland. In the Sand sparse forest land, there are also some breeding individuals like Kestrel, Magpie and Woodpecker.

Wetland

The wetland ecological type in Hulunbuir Steppe is very complex, we could see all the wetland type except ocean and constructed wetlands in this area, and the area is vast. This area is a good breeding and rest area for water birds. Red-crowned crane, White-naped Crane, Eurasian Spoonbill, Swan Goose, Grey Goose, Anasplatyrhynchos, Mute Swan, Whooper Swan, FulicaAtra, Great Crested Grebe breed in reed marshes, river and lake flood-plain meadow. LarusArgentatus, Seagull, Black-headed Gull, Sea Swallow, White-winged Tern, Northern Lapwing and

Kentish Plover nest on the sand beach and mud bank. Vast water area and variety of wetland types provide breeding and passing water birds with rich foods. In the wetland ecological system, there are also some Passeriformes and birds that rely on reed and scrub pasture. Bearded Reedling and Reed Parrotbill stay in the reed all year round, Willow Warbler, Reed Warble, Tyrannulet, Bunting, Tit, Pipit, Snipe and Shrike also breed and forage in the wetland. In a word, the wetlands in Hulunbuir Steppe supporting hundreds of thousands of migrating water birds passing and breeding. (See Distribution Diagram of Grassland Birds in Hulunbuir Steppe in Attachment II).

Conclusions

In conclusion, there are a great variety and number of birds in Hulunbuir Steppe with little human influence. However, the long drought caused by climate change has seriously threatened the birds of this area. Several main rivers on Hulunbuir Steppe have all changed to some extent. Kherlen river which originates from east of Khentii Mountains, Mongolia is 1264 kilometers long, and it is the main supply water source of Dalai Lake. From 2000, the river runoff of Kherlen River has dramatically reduced and has appeared event of cutoff on September 8th, 2007 due to continuous drought. Wuerxun River is another main water supply source for Dalai Lake, but it also appeared cutoff in 2007. Benefit from the heavy rainfall from 2010 to 2012, Kherlen River and Moergele River have restored runoff which is equal to 2008, and Wuerxun River didn't restore runoff until 2010. The volume of runoff of Hailaar River reduced from 2.4 billion cubic meters every year to 1.3 billion cubic meters. The long-term climate change research shows that the climate of Hulunbuir will get warmer (IPCC, 2007). Although the amount of precipitation will increase, but this amount is far less than the evaporation capacity due to climate warming. In 2013, the amount of precipitation in Hulunbuir has increased noticeably, and the amount almost equal to the amount of 1998, the annual runoff volume of several rivers were far surpassed the previous years, the water lever of the lake increased rapidly, it increased about 1.5 meters. However, the climate of 2013 is very special and could not be a long –term phenomenon, so the wetland of Hulunbuir Steppe is still facing serious threats from reduced inflow of water. Therefore, conducting close monitoring on the composition and number of birds in Hulunbuir, and studying the effect of climate on birds is crucial for conservation work of birds in Hulunbuir area.

Reference

Bart, J. 2005. *Guidelines for designing short-term bird monitoring projects*. U S Forest Service General Technical Report PSW, 191: 985-992.

BirdLife International. 2006a. *Grus monacha*. IUCN Red List of Threatened Species. IUCN 2006.

BirdLife International. 2006b. *Grus vipio*. IUCN Red List of Threatened Species.IUCN 2006.www.iucnredlist.org. Retrieved on 11 May 2006.

BirdLife International. 2008a. *2008 IUCN Redlist status changes*. Pages Retrieved 2008-MAY-2023.

BirdLife International. 2008b. *Anser cygnoides*. Page Downloaded on 08 September 2010. IUCN 2010. IUCN Red List of Threatened Species.Version 2010.3.<www.iucnredlist.org>.

BirdLife International. 2008c. *Grus japonensis*. IUCN 2008.IUCN Red List of Threatened Species.

Hoyo, J. D, Elliot, A. & Sargatal, J. 1992. *Handbook of the Birds of the World*, Vol. 1. Lynx Edicions, Barcelona.

Integrated team in Inner Mongolia and Ning Xia of Chinese Academy of Sciences (CAS). 1985. *Vegetation of Inner Mongolia*. Science Press, Beijing.

IPCC. 2007. *Climate change 2007: the physical science basis*. Contribution of Working Group I to the Fourth Assessment.Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

IUCN 2004.*IUCN Red List of Threatened Species*.

Lei, F. 1996. Research on Population Density and Ecological Distribution Pattern of Little Owl. *Journal of Ecology*, 16: 333-336.

Lv, S. 2010a. Plan on Biodiversity Protection and Management on Hulunbuir Steppe. *Chinese Research Academy of Environmental Sciences*, Beijing.

Lv, S. 2010b. Ecological City Construction Plan of Hulunbuir.*Chinese Research Academy of Environmental Sciences*, Beijing.

Sutherland, W. J. 1996. *Ecological census techniques: a handbook*. Cambridge University Press, Cambridge.

Tozer, D. C., Abraham, K.F. & Nol, E. 2006. Improving the accuracy of counts of wetland breeding birds at the point scale. *Wetlands*, 26: 518-527.

The Ministry of Forestry and Agriculture. 1989. *National Wildlife Protection List*. Beijing.

Xu, Z., Feng, N., Wang, Z., Chang, X. & Xiao, H. 2006. Distribution and Protection Measures of Relict Gull in Hongjianzhuo Wetland of Shanxi Provence. *Journal of Northwest Forestry University*. 21: 126-129.

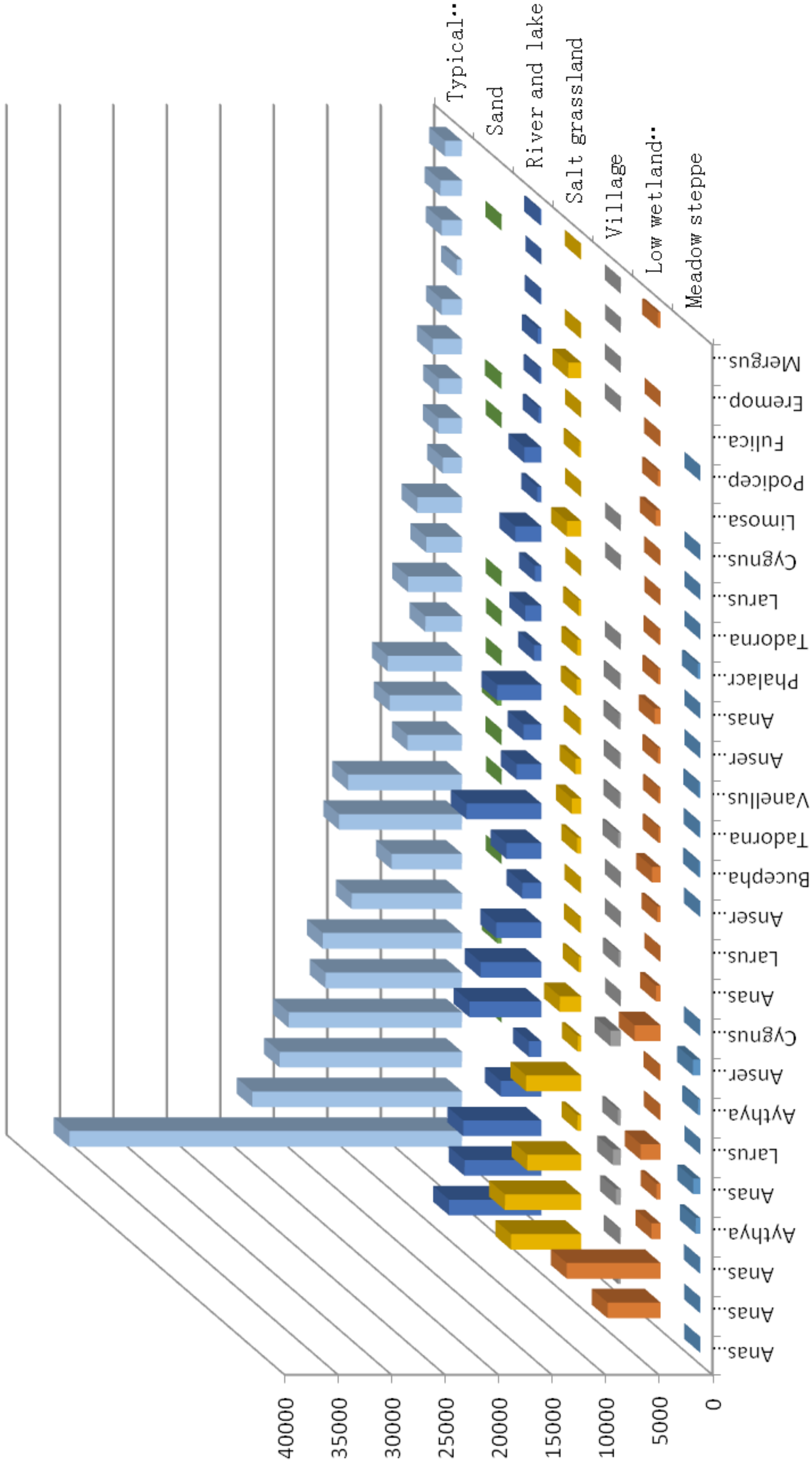
Appendix I: Bird List of Hulunbuir Steppe

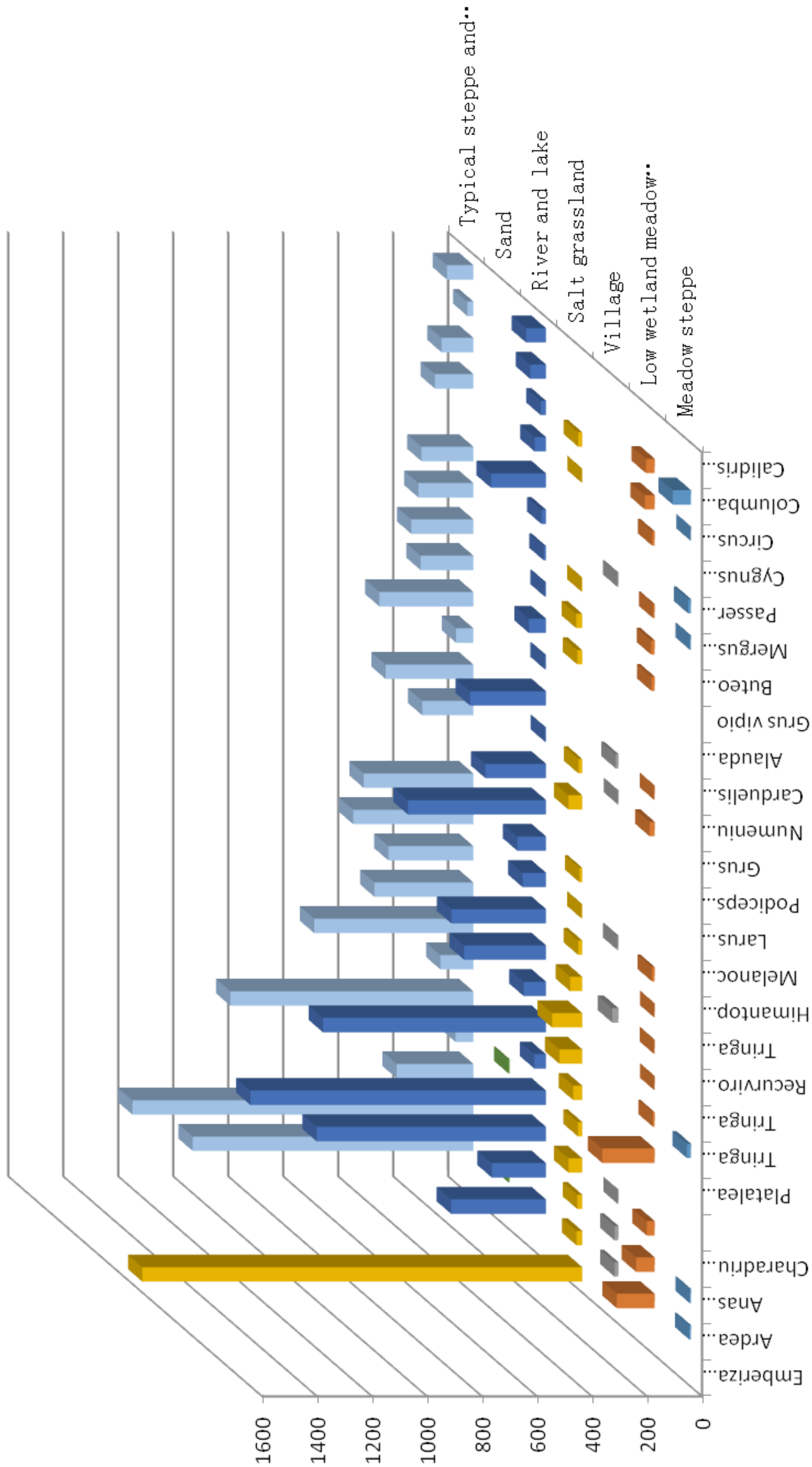
Latin names	Order	Family	IUCN	China National Protected Species Category
Podiceps grisegena	**Podicipediformes**	**Podicipedidae**	LC	II
Podiceps cristatus	**Podicipediformes**	**Podicipedidae**	LC	
Podiceps nigricollis	**Podicipediformes**	**Podicipedidae**	LC	
Phalacrocorax carbo	**Pelecaniformes**	**Phalacrocoracidae**	LC	
Ardea cinerea	**Ciconiiformes**	**Ardeidae**	LC	
Ardea purpurea	**Ciconiiformes**	**Ardeidae**	LC	
Egretta garzetta	**Ciconiiformes**	**Ardeidae**	LC	
Egretta alba	**Ciconiiformes**	**Ardeidae**	LC	
Botaurus stellaris	**Ciconiiformes**	**Ardeidae**	LC	
Platalea leucorodia	**Ciconiiformes**	**Threskiornithidae**	LC	II
Cygnus cygnus	**Anseriformes**	**Anatidae**	NT	II
Cygnus columbianus	**Anseriformes**	**Anatidae**	NT	II
Cygnus olor	**Anseriformes**	**Anatidae**	NT	II
Anser albifrons	**Anseriformes**	**Anatidae**	LC	II
Anser cygnoides	**Anseriformes**	**Anatidae**	VU	
Anser anser	**Anseriformes**	**Anatidae**	LC	
Anser fabalis	**Anseriformes**	**Anatidae**	LC	
Tadorna tadorna	**Anseriformes**	**Anatidae**	LC	
Tadorna ferruginea	**Anseriformes**	**Anatidae**	LC	
Anas querquedula	**Anseriformes**	**Anatidae**	LC	
Anas poecilorhyncha	**Anseriformes**	**Anatidae**	LC	
Anas strepera	**Anseriformes**	**Anatidae**	LC	
Anas penelope	**Anseriformes**	**Anatidae**	LC	
Anas crecca	**Anseriformes**	**Anatidae**	LC	
Anas poecilorhyncha	**Anseriformes**	**Anatidae**	LC	
Anas falcata	**Anseriformes**	**Anatidae**	NT	
Anas clypeata	**Anseriformes**	**Anatidae**	LC	
Anas strepera	**Anseriformes**	**Anatidae**	LC	
Anas acuta	**Anseriformes**	**Anatidae**	LC	
Aythya fuligula	**Anseriformes**	**Anatidae**	LC	
Aythya ferina	**Anseriformes**	**Anatidae**	□	
Aythya baeri	**Anseriformes**	**Anatidae**	VU	
Netta rufina	**Anseriformes**	**Anatidae**	LC	
Melanitta fusca	**Anseriformes**	**Anatidae**	LC	
Bucephala clangula	**Anseriformes**	**Anatidae**	LC	
Mergus albellus	**Anseriformes**	**Anatidae**	LC	
Mergus serrator	**Anseriformes**	**Anatidae**	LC	
Mergus merganser	**Anseriformes**	**Anatidae**	LC	
Milvus migrans	**Falconiformes**	**Accipitridae**	LC	II
Haliaeetus albicilla	**Falconiformes**	**Accipitridae**	NT	I
Butas turindicus	**Falconiformes**	**Accipitridae**	LC	II
Circus spilonotus	**Falconiformes**	**Accipitridae**	LC	II
Circus cyaneus	**Falconiformes**	**Accipitridae**	LC	II
Circus aeruginosus	**Falconiformes**	**Accipitridae**	LC	II
Circus melanoleucos	**Falconiformes**	**Accipitridae**	LC	II
Accipiter gentilis	**Falconiformes**	**Accipitridae**	LC	II
Buteo hemilasius	**Falconiformes**	**Accipitridae**	LC	II
Buteo lagopus	**Falconiformes**	**Accipitridae**	LC	II
Buteo buteo	**Falconiformes**	**Accipitridae**	LC	II
Aquila nipalensis	**Falconiformes**	**Accipitridae**	LC	II
Aquila chrysaetos	**Falconiformes**	**Accipitridae**	LC	I
Aquila clanga	**Falconiformes**	**Accipitridae**	VU	II
Falco tinnunculus	**Falconiformes**	**Falconidae**	LC	II

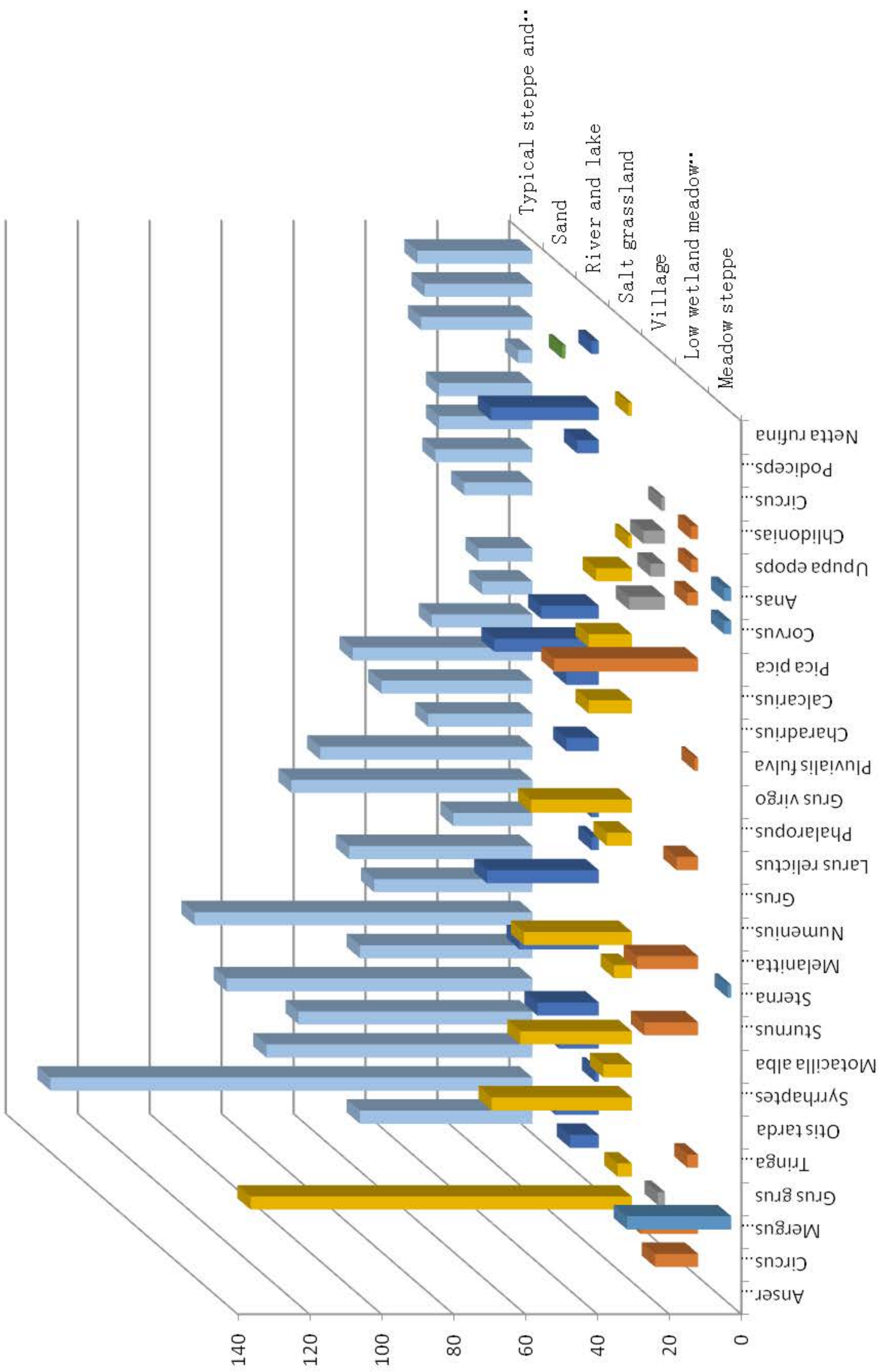
Falco cherrug	**Falconiformes**	**Falconidae**	LC	II
Falco subbuteo	**Falconiformes**	**Falconidae**	LC	II
Falco amurensis	**Falconiformes**	**Falconidae**	LC	II
Perdix dauuricae	**Galliformes**	**Phasianidae**	LC	
Grus leucogeranus	**Gruiformes**	**Gruidae**	CR	I
Grus monacha	**Gruiformes**	**Gruidae**	VU	I
Grus vipio	**Gruiformes**	**Gruidae**	VU	II
Grus japonensis	**Gruiformes**	**Gruidae**	EN	I
Grus grus	**Gruiformes**	**Gruidae**	LC	II
Grus virgo	**Gruiformes**	**Gruidae**	LC	II
Fulica atra	**Gruiformes**	**Rallidae**	LC	
Otis tarda	**Gruiformes**	**Otidae**	VU	I
Recurvirostra avosetta	**Charadriiformes**	**Recurvirostridae**	LC	
Himantopus himantopus	**Charadriiformes**	**Recurvirostridae**	LC	
Glareo lamaldivarum	**Charadriiformes**	**Glareolidae**	LC	
Pluvialis fulva	**Charadriiformes**	**Charadriidae**	LC	
Pluvialis squatarola	**Charadriiformes**	**Charadriidae**	LC	
Vanellus vanellus	**Charadriiformes**	**Charadriidae**	LC	
Charadrius asiaticus	**Charadriiformes**	**Charadriidae**	LC	
Charadrius alexandrinus	**Charadriiformes**	**Charadriidae**	LC	
Charadrius dubius	**Charadriiformes**	**Charadriidae**	LC	
Charadrius veredus	**Charadriiformes**	**Charadriidae**	LC	
Charadrius mongolus	**Charadriiformes**	**Charadriidae**	LC	
Charadrius leschenaultia	**Charadriiformes**	**Charadriidae**	LC	
Limosa lapponica	**Charadriiformes**	**Sandpiper**	LC	
Limosa limosa	**Charadriiformes**	**Sandpiper**	LC	
Limnodromus semipalmatus	**Charadriiformes**	**Sandpiper**	NT	
Numenius arquata	**Charadriiformes**	**Sandpiper**	LC	
Numenius madagascariensis	**Charadriiformes**	**Sandpiper**	NT	
Numenius minutus	**Charadriiformes**	**Sandpiper**	LC	II
Tringa erythropus	**Charadriiformes**	**Sandpiper**	LC	
Tringa tetanus	**Charadriiformes**	**Sandpiper**	LC	
Tringa ochropus	**Charadriiformes**	**Sandpiper**	LC	
Tringa stagnatilis	**Charadriiformes**	**Sandpiper**	LC	
Tringa glareola	**Charadriiformes**	**Sandpiper**	LC	
Tringa nebularia	**Charadriiformes**	**Sandpiper**	LC	
Actitis hypoleucos	**Charadriiformes**	**Sandpiper**	LC	
Calidris ruficollis	**Charadriiformes**	**Sandpiper**	LC	
Calidris acuminuta	**Charadriiformes**	**Sandpiper**	LC	
Calidris alba	**Charadriiformes**	**Sandpiper**	LC	
Calidris temminckii	**Charadriiformes**	**Sandpiper**	LC	
Gallinago gallinago	**Charadriiformes**	**Sandpiper**	LC	
Gallinago stenura	**Charadriiformes**	**Sandpiper**	LC	
Gallinago megala	**Charadriiformes**	**Sandpiper**	LC	
Phalaropus lobatus	**Charadriiformes**	**Sandpiper**	LC	
Larus canus	**Lariformes**	**Laridae**	LC	
Larus crassirostris	**Lariformes**	**Laridae**	LC	
Larus ridibundus	**Lariformes**	**Laridae**	LC	
Larus schistisagus	**Lariformes**	**Laridae**	LC	
Larus relictus	**Lariformes**	**Laridae**	VU	I
Larus heuglini	**Lariformes**	**Laridae**	LC	
Chlidonias leucoptera	**Lariformes**	**Laridae**	LC	
Chlidonias hybrida	**Lariformes**	**Laridae**	LC	
Sterna hirundo	**Lariformes**	**Laridae**	LC	
Sterna caspia	**Lariformes**	**Laridae**	LC	
Syrrhaptes paradoxus	**Columbiformes**	**Pteroclidae**	LC	
Columba rupestris	**Columbiformes**	**Columbidae**	LC	

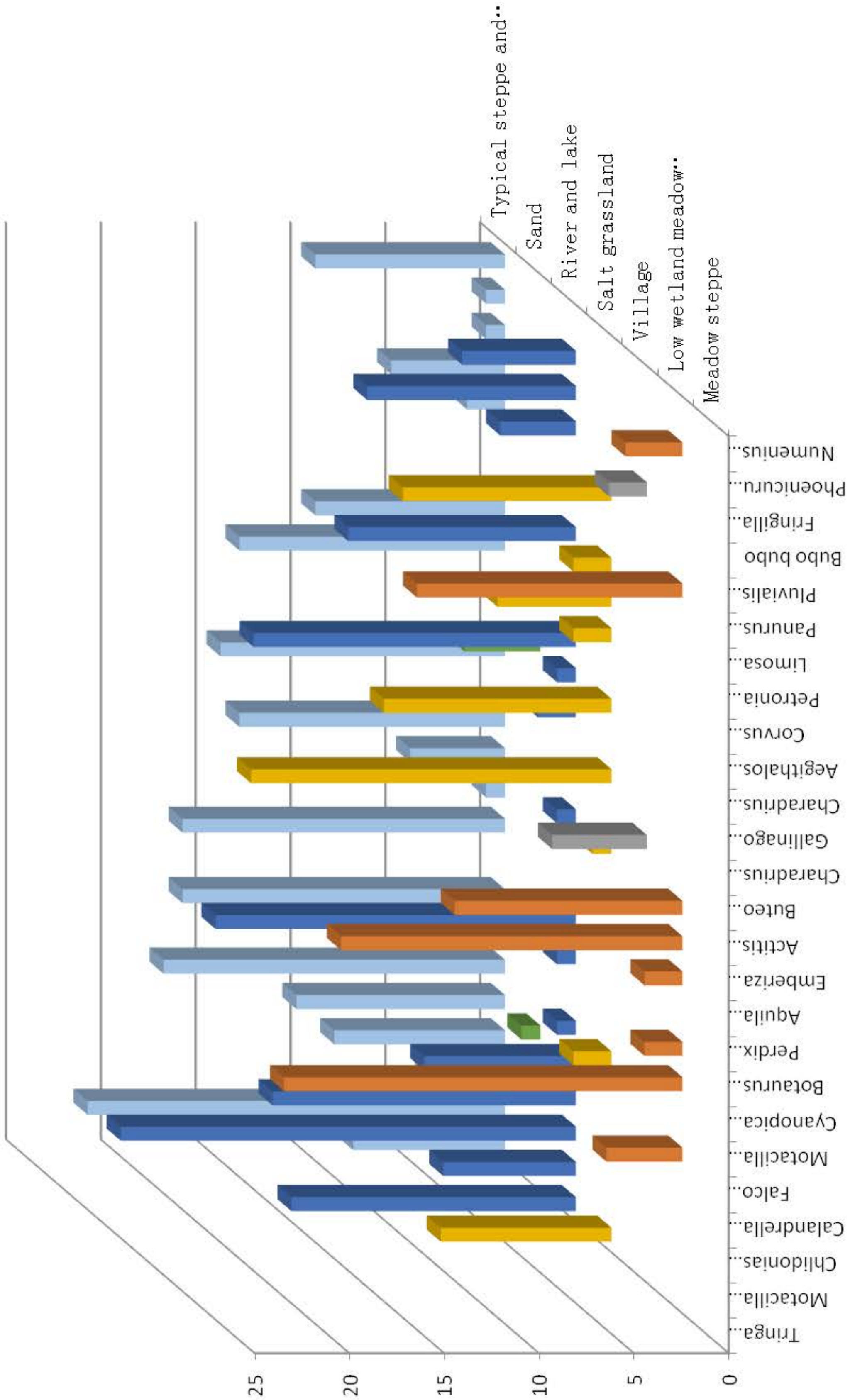
Athene noctua	**Strigiformes**	**Strigidae**	LC	II
Asio otus	**Strigiformes**	**Strigidae**	LC	II
Asio flammeus	**Strigiformes**	**Strigidae**	LC	II
Bubo bubo	**Strigiformes**	**Strigidae**	LC	
Nyctea scandiaca	**Strigiformes**	**Strigidae**	LC	II
Apus pacificus	**Apodiformes**	**Apodidae**	□	
Picoides major	**Piciformes**	**Woodpecker**	LC	
Jynx torquilla	**Piciformes**	**Woodpecker**	LC	
Upupa epops	**Coraciiformes**	**Upupidae**	LC	
Melanocorypha mongolica	**Passeriformes**	**Alaudidae**	NT	
Eremophila alpestris	**Passeriformes**	**Alaudidae**	LC	
Alauda arvensis	**Passeriformes**	**Alaudidae**	LC	
Calandrellabrachydactyla	**Passeriformes**	**Alaudidae**	LC	
Calandrella cheleensis	**Passeriformes**	**Alaudidae**	LC	
Riparia riparia	**Passeriformes**	**Hirundinidae**	LC	
Hirundo rustica	**Passeriformes**	**Hirundinidae**	LC	
Motacilla flava	**Passeriformes**	**Motacillidae**	LC	
Motacilla citreola	**Passeriformes**	**Motacillidae**	LC	
Motacilla cinerea	**Passeriformes**	**Motacillidae**	LC	
Motacilla alba	**Passeriformes**	**Motacillidae**	LC	
Corvus corone	**Passeriformes**	**Corvidae**	LC	
Corvus macrorhynchos	**Passeriformes**	**Corvidae**	LC	
Corvus dauurica	**Passeriformes**	**Corvidae**	LC	
Corvus torquatus	**Passeriformes**	**Corvidae**	LC	
Cyanopica cyana	**Passeriformes**	**Corvidae**	LC	
Pica pica	**Passeriformes**	**Corvidae**	NT	
Bombycilla garrulus	**Passeriformes**	**Bombycillidae**	LC	
Sturnus cineraceus	**Passeriformes**	**Sturnidae**	LC	
Turdus naumanni	**Passeriformes**	**Muscicapidae**	LC	
Phoenicurus auroreus	**Passeriformes**	**Muscicapidae**	LC	
Turdus ruficollis	**Passeriformes**	**Muscicapidae**	LC	
Ficedula parva	**Passeriformes**	**Muscicapidae**	LC	
Oenanthe isabellina	**Passeriformes**	**Muscicapidae**	LC	
Oenanthe oenanthe	**Passeriformes**	**Muscicapidae**	LC	
Zoothera dauma	**Passeriformes**	**Muscicapidae**	LC	
Phylloscopus inornatus	**Passeriformes**	**Sylviidae**	LC	
Lanius cristatus	**Passeriformes**	**Laniidae**	LC	
Parus major	**Passeriformes**	**Paridae**	LC	
Carduelis spinus	**Passeriformes**	**Fringillidae**	LC	
Fringilla montifringilla	**Passeriformes**	**Fringillidae**	LC	
Carduelis flammea	**Passeriformes**	**Fringillidae**	LC	
Uragus sibiricus	**Passeriformes**	**Fringillidae**	LC	
Passer montanus	**Passeriformes**	**Ploceidae**	NT	
Petronia petronia	**Passeriformes**	**Ploceidae**	LC	
Passer domesticus	**Passeriformes**	**Ploceidae**	NT	
Panurus biarmicus	**Passeriformes**	**Paradoxornithidae**	LC	
Aegithalos caudatus	**Passeriformes**	**Aegithalidae**	LC	
Emberiza leucocephalos	**Passeriformes**	**Emberizidae**	LC	
Emberiza rustica	**Passeriformes**	**Emberizidae**	LC	
Emberiza schoeniclus	**Passeriformes**	**Emberizidae**	LC	
Emberiza pallasi	**Passeriformes**	**Emberizidae**	LC	
Emberiza yessoensis	**Passeriformes**	**Emberizidae**	NT	
Emberiza pusilla	**Passeriformes**	**Emberizidae**	LC	
Emberiza cioides	**Passeriformes**	**Emberizidae**	LC	
Emberiza spodocephala	**Passeriformes**	**Emberizidae**	LC	
Calcarius lapponicus	**Passeriformes**	**Emberizidae**	LC	

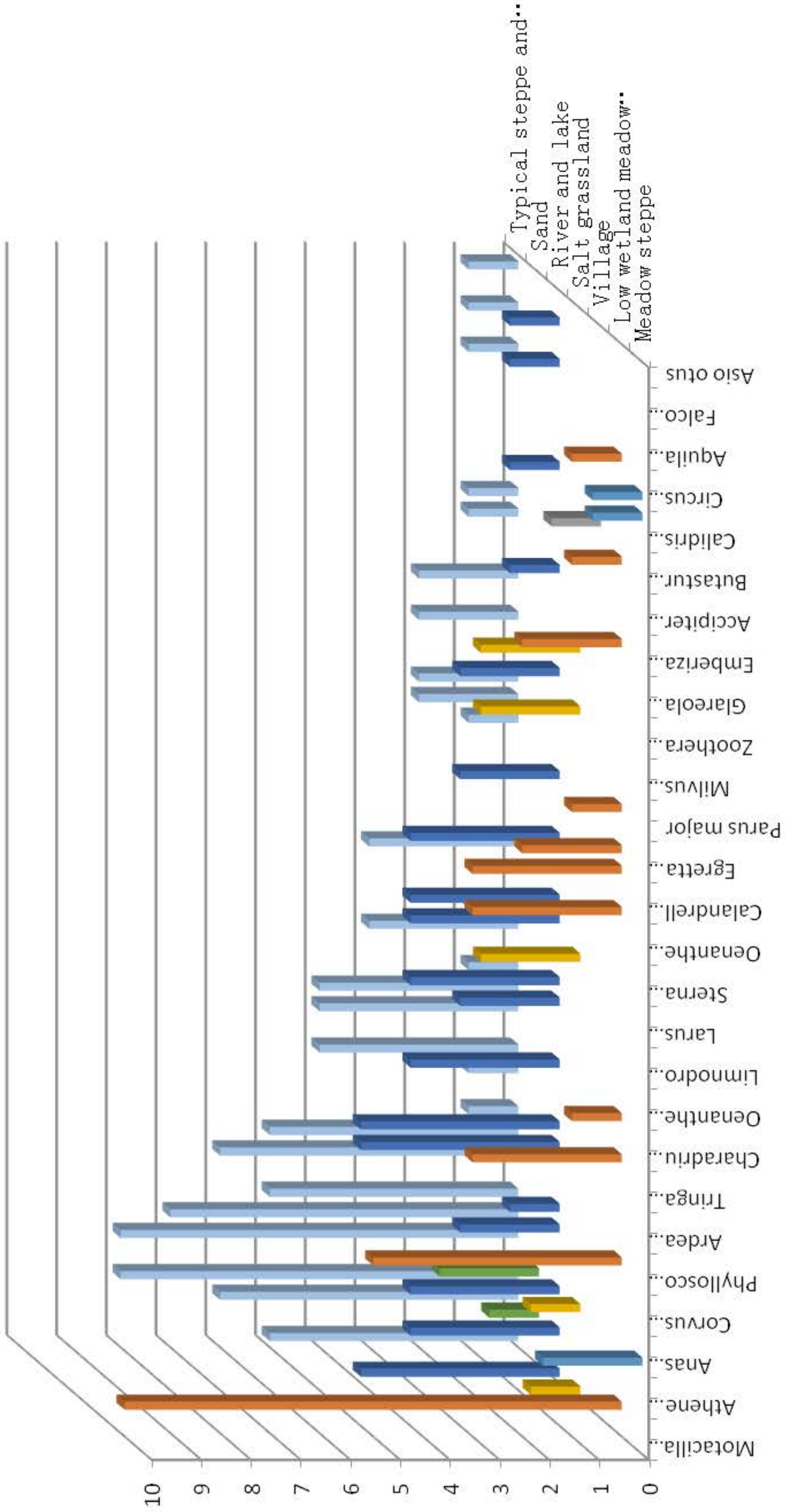
Attachment II: Distribution Diagram of Grassland Birds in Hulunbuir Steppe

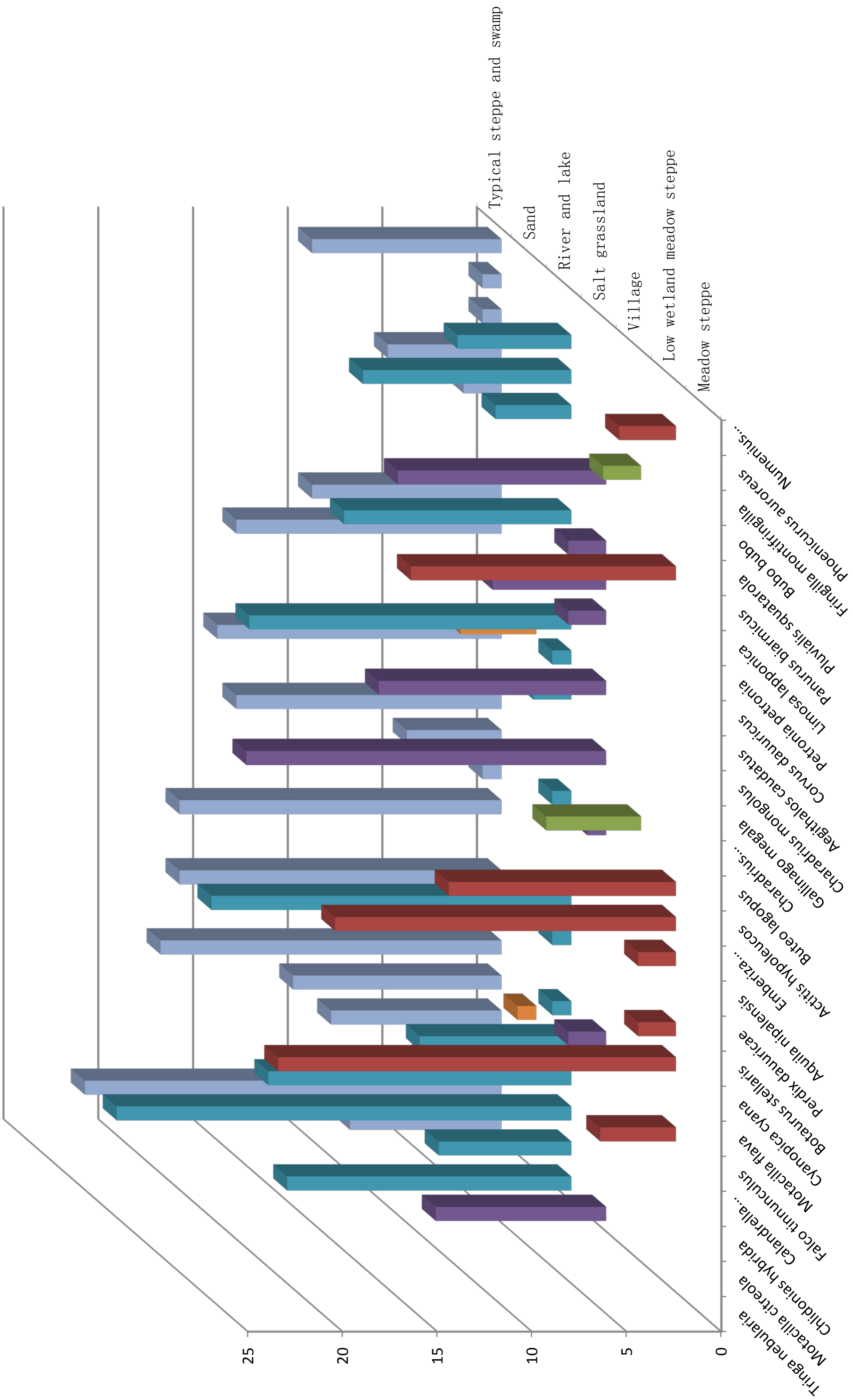



Typical steppe and··
Sand
River and lake
Salt grassland
Village
Low wetland meadow··
Meadow steppe
Calidris…
Columba…
Circus…
Cygnus…
Passer…
Mergus…
Buteo…
Grus vipio
Alauda…
Carduelis…
Numeniu…
Grus…
Podiceps…
Larus…
Melanoc…
Himantop…
Tringa…
Recurviro…
Tringa…
Tringa…
Platalea…
Charadriu…
Anas…
Ardea…
Emberiza…
0
200
400
600
800
1000
1200
1400
1600


Typical steppe and…
Sand
River and lake
Salt grassland
Village
Low wetland meadow…
Meadow steppe
Netta rufina
Podiceps…
Circus…
Chlidonias…
Upupa epops
Anas…
Corvus…
Pica pica
Calcarius…
Charadrius…
Pluvialis fulva
Grus virgo
Phalaropus…
Larus relictus
Grus…
Numenius…
Melanitta…
Sterna…
Sturnus…
Motacilla alba
Syrrhaptes…
Otis tarda
Tringa…
Grus grus
Mergus…
Circus…
Anser…
0
20
40
60
80
100
120
140


Typical steppe and…
Sand
River and lake
Salt grassland
Village
Low wetland meadow…
Meadow steppe
Tringa…
Motacilla…
Chlidonias…
Calandrella…
Falco…
Motacilla…
Cyanopica…
Botaurus…
Perdix…
Aquila…
Emberiza…
Actitis…
Buteo…
Charadrius…
Gallinago…
Charadrius…
Aegithalos…
Corvus…
Petronia…
Limosa…
Panurus…
Pluvialis…
Bubo bubo
Fringilla…
Phoenicuru…
Numenius…
0
5
10
15
20
25


Typical steppe and··
Sand
River and lake
Salt grassland
Village
Low wetland meadow··
Meadow steppe
Motacilla...
Athene...
Anas...
Corvus...
Phyllosco...
Ardea...
Tringa...
Charadriu...
Oenanthe...
Limnodro...
Larus...
Sterna...
Oenanthe...
Calandrell...
Egretta...
Parus major
Milvus...
Zoothera...
Glareola...
Emberiza...
Accipiter...
Butastur...
Calidris...
Circus...
Aquila...
Falco...
Asio otus
0
1
2
3
4
5
6
7
8
9
10


Typical steppe and swamp
Sand
River and lake
Salt grassland
Village
Low wetland meadow steppe
Meadow steppe
Numenius...
Phoenicurus auroreus
Fringilla montifringilla
Bubo bubo
Pluvialis squatarola
Panurus biarmicus
Limosa lapponica
Petronia petronia
Corvus dauuricus
Aegithalos caudatus
Charadrius mongolus
Gallinago megala
Charadrius...
Buteo lagopus
Actitis hypoleucos
Emberiza...
Aquila nipalensis
Perdix dauuricae
Botaurus stellaris
Cyanopica cyana
Motacilla flava
Falco tinnunculus
Calandrella...
Chlidonias hybrida
Motacilla citreola
Tringa nebularia
0
5
10
15
20
25

Mammals Recorded in Daurian International Protected Area (DIPA)

V.Kirilyuk[1], B.Delgermaa[2], Dou Huashan[3]

[1] *Daursky State Nature Biosphere Reserve, Nizhny Tsasuchey, Zabaikalsky krai, Russia*
[2] *Eastern Mongolia Protected Area Administration, Choibalsan, Dornod, Mongolia*
[3] *College of Life Science, Qufu Normal University, Qufu, 273165, China*

The list includes mammal species registered in the Russian-Mongolian-Chinese *Dauria* international protected area (DIPA), which comprises the *Mongol Daguur* Strictly Protected Area (SPA) (Mongolia), the *Dalaynor* Nature Reserve (China) and the *Daursky* Nature Reserve (Russia). The presented list of mammals refers not only to the boundaries of the mentioned specially protected nature areas but to the buffer zones of the *Mongol Daguur* SPA and the *Daursky* NR. The name '*Daursky* NR' in the table stands also for the territories of the two zakazniks: *Tsasucheiskybor* and *Dzeren Valley* that are also a part of the DIPA on its Russian side.

While compiling the list different sources were used besides the bibliography given below (Table 1), among those are appendices to the Management plans, to the nominations for acquiring the status of a biosphere reserve, etc. In those sources the authors of the lists are not always known; moreover, the lists were not scientifically proved. Taking this into consideration, all obvious errors in the species identification or simultaneous use of the out-of-date and new classifications for the same species were corrected. The presence of the species from the list, which can be doubted in the area, is marked only with a dot on the large-scale map, the presence of the species, which is known by its habitation in the adjacent sites, is shown with a question mark.

Table 1. Species list of mammals recorded in Daura International Protected Area

Order	Family	Species name	English name	Mongol Daguur SPA	Dalailake NR	Daursky NR
INSECTIVORIA	Erinaceidae	*Mesechinus dauuricus*	Daurian Hedgehog	+	+	+
		Sorex caecutiens	Laxmann's Shrew			+
		S. daphaenodon	Large-Toothed Siberian Shrew			+
		S. tundrensis	Tundra Shrew	+		+
		S.minutissimus	Eurasian Least Shrew			+
CHIROPTHERA	Vespertilinoidae	*Plecotus auritus*	Brown Long-Eared Bat			+
		Vespertilio murinus	Particoloured Bat	+	+	+
		Vespertilio superans	Eastern Bat	+	+	+
		Myotis mystacinus	Whiskered Myotis	+	+	+
		Myotis myotis	Large Mouse-Eared Bat		+	
		Myotis daubentoni	Daubenton's Myotis		+	+
		Myotis brandtii	Brandt's Myotis	?		
		Myotis ikonnikovi	Ikonnikov's Myotis	?		
CARNIVORA	Felidae	*Otocolobus manul*	Pallas' Cat	+	+	+
		Prionailurus bengalensis	Leopard Cat		?	
		Lynx lynx	Lynx	+		+
	Canidae	*Canis lupus*	Gray Wolf	+	+	+
		Vulpes vulpes	Red Fox	+	+	+
		Vulpes corsac	Corsac Fox	+	+	+
		Nyctereutes procyonoides	Raccoon Dog	+	+	+
	Mustelidae	*Lutra lutra*	Eurasian Otter		+	
		Meles meles	Eurasian Badger	+	+	+
		Mustela nivalis	Least Weasel	+	+	+
		M.erminea	Ermine			?

		M. altaica	Mountain Weasel	+	+	+
		M. eversmanni	Steppe Polecat	+	+	+
		M.sibirica	Siberian Weasel		+	+
LAGOMORPHA	Leporidae	*Lepus mandshuricus*	Manschurian Hare		+	
		L. timidus	Mountain Hare	+		+
		L.tolai	Tolai Hare	+	+	+
	Ochotonidae	*Ochotona dauurica*	Daurian Pika	+	+	+
		Och. hyperborea	Northern Pika	?		
RODENTIA	Sciuridae	*Spermophilus dauricus*	Daurian Ground Squirrel	+	+	+
		Sp. undulatus	Long-Tailed Ground Squrrel			+
		Tamias sibiricus	Sibirian Chipmunk	+		?
		Sciurus vulgaris	Eurasian Red Squirrel			+
		Marmota sibirica	Tarbagan Marmot	+	+	+
	Dipodidae	*Allactaga sibirica*	Mongolian Five-Toed Jerboa	+	+	+
		Dipus sagitta	Hairy-footed Jerboa		+	
	Cricetidae	*Cricetulus pseudogriseus*	Transbaikal Hamster	+		+
		Cricetulus barabensis	Striped Dwarf Hamster		+	
		Phodopus campbelli	Campbell's Hamster	+	+	+
		Phodopus roborovskii	Desert Hamster		+	
		Myodes rutilus	Northen Red-Backed Vole			+
		Lasiopodomys brandti	Brandt's Vole	+	+	+
		Microtus gregalis	Narrow-Headed Vole	+	+	+
		M.fortis	Reed Vole	+		+
		M.maximowiczii	Maximowicz's Vole	+	+	+
		M. mongolicus	Mongolian Vole	+		+
		Alticola argentatus	Royle's Mountain Vole	?		
		Apodemus agrarius	Striped Field Mouse	?		
		Apodemus peninsulae	Korean Field Mouse	+		+
		Ondatra zibethicus	Muskrat	+	+	+
	Gerbilidae	*Meriones unguiculatus*	Mongolian Gerbil	+	+	+
	Muridae	*Micromys minutus*	Harvest Mouse	+		+
		Mus musculus	House Mouse	+	+	+
		Rattus norvegicus	Brown Rat		+	+
	Spalacidae	*Myospalax aspalax*	Steppe Zokor	+		+
ARTIODACTYLA	Suidae	*Sus scrofa*	Wild Boar	+		+
	Bovidae	*Procapra gutturosa*	Mongolian Gazelle	+	+	+
	Cervidae	*Capreolus pygargus*	Siberian Roe Deer	+	+	+
		Cervus elaphus	Red Deer	+		+
			Total	39 (44?)	36 (37?)	48(50?)

References

Bazhenov Y.A., Kirilyuk V.E. in print. Mammals of Daursky Biosphere Reserve.

Bazhenov, A. Information Report researcher Daurskiy Reserve Bazhenov YA Scientific expeditions to Mongolia in 2013.

Clark, E. L., Munkhbat, J., Dulamtseren, S., Baillie, J. E. M., Batsaikhan, N., Samiya, R. and Stubbe, M. (compilers and editors). 2006. Mongolian Red List of Mammals. Regional Red List Series Vol. 1. Zoological Society of London, London. (In English and Mongolian)

Hoffmann R.S. et al. 2008. *A guide to the mammals of China*. Andrew T. Smith and Yan Xie, editors. Princeton University Press

Kiriliuk, V.E. 2003. Annotated list of mammals of the Biosphere Reserve "Daursky" and protected area "Tsasucheyskybor" In *The ground vertebrates of Dauria*. Poisk: Chita. Pp. 7-19.

Management plan: Mongol Daguur Strictly Protected Area. 2005 (appendices)

Tseveenmyadag, N. 2003. The ground vertebrates of «Mongol Daguur» Strictly Protected Area. In *The ground vertebrates of Dauria*. Poisk: Chita. Pp. 33-43.