PLANT GERMPLASM COLLECTION REPORT

Collection of Low-Maintenance Turf Germplasm in Kyrgyzstan

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Summary: Plant germplasm from Kyrgyzstan is poorly represented in genebanks of the U.S. and has the potential to expand existing germplasm for the improvement of turf for tolerance to drought, mowing, and low temperatures. As a result, the USDA Germplasm Exploration Fund supported a project to collection seed of *Agrostis, Festuca, Koeleria, Poa, Puccinellia,* and other grass genera in eastern Kyrgyzstan that have potential for low-maintenance turf applications in the western U.S. When opportunities arose, we also made seed collections of grass and legume species that have potential for forage or conservation applications. A total of 266 collections covering a wide diversity of grass and legume species were made throughout Chu, Issyk-Kul, and Naryn Oblasts of Kyrgyzstan. Voucher specimens were prepared for most collections for use at the Smithsonian Institution with duplicate specimens for other institutions. Leaves of *Poa* collections were preserved in silica gel packets for future DNA analyses.

Participants from the U.S. and Russia arrived in Bishkek on 3 August 2006 and were met by colleagues from the Kyrgyz Scientific Research Institute of Livestock, Veterinary, and Pastures. On 5 August 2006 we began an 18-day collection trip to eastern Kyrgyzstan. Our collection route took us east from Bishkek to Balykchi, and then east between the southern slopes of the

Zaliisky Alatau and the northern shores of Lake Issyk-Kul in the regions of Cholpon-Ata and Tyup. We then traveled west-southwest of Tyup through the Jeti Oguz and Ton Regions between the southern shores of Lake Issyk-Kul and northern slopes of the Terskey Alatau. Our travel route then took us through the Kochkorka, Tien Shan, At-Bashy Ak-Tal, and Dzhumgal Regions in Naryn Province where we made collections in the At-Bashy and Tien Shan Ranges. We then traveled north through Chu Province and made collections in Suusamyr Valley and Kyrgyz Alatau. We returned to Bishkek on 22 August 2006.

In Bishkek we cleaned, weighed, and divided our seed collections with portions going to Kyrgyzstan, Russia, and the U.S. Seed collections were inspected by officials at the Department of Chemistry, Plant Protection, and Quarantine Service in Bishkek, which issued Export Permits for seed and herbarium specimens and Phytosanitary Certificates. We departed Bishkek on 27 August 2006. The Russian portion of the seed and herbarium specimens were hand-carried as luggage back to the N.I.Vavilov Research Institute of Plant Industry in St. Petersburg. The U.S. portion of the seed collections was delivered to Homeland Security inspectors at the JFK International Airport in New York where they were sent to the USDA Plant Germplasm Quarantine Center in Beltsville, Maryland for processing. The herbarium specimens and leaf DNA samples were inspected by Homeland Security at Dulles International Airport and brought to the Smithsonian Institution in Washington, DC. The seed collections will be given final cleaning in Logan and be sent to the Western Plant Introduction Station in Pullman, WA, where they will be incorporated into the U.S. National Plant Germplasm System. These collections will be available for research to scientists around the world and evaluated in breeding programs at Logan for potential use in low-maintenance turf, forage, and conservation applications in the western U.S.

Recommendations: Livestock numbers are greatly reduced compared to numbers present during the Soviet period (e.g., 14 million sheep in Soviet times compared to 3.5 million now). Despite these low numbers, many of Kyrgyzstan's rangelands were heavily grazed. Weedy species are invading the more severely overgrazed areas. The Government of Kyrgyzstan should take measures to institute proper grazing management and monitoring of their rangelands. There is a need for additional collections in western Kyrgyzstan and adjoining countries for low-maintenance turf germplasm to make sure that germplasm from this unique part of the world is preserved and available for future generations.

Acknowledgments: The success of our trip was directly attributable to the collective efforts of individual team members and our drivers. We wish to thank Kanat Samsaliev for planning, organizing, and facilitating all aspects of our collection trip. We thank Amantai Samsaliev for obtaining the necessary travel permits, Prior Informed Consent, Export Permits, and Phytosanitary Certificates. Special thanks go to Sergey Shuvalov and Vladimir Chapurin for their excellent translation skills, hard work, dedication, and friendship. Appreciation is also extended to Rob Soreng for his superb taxonomic and GPS documentation skills. Thanks also go to our two drivers (Tuganbai and Kolya) for their skillful driving, excellent cooking skills, warm friendship, and superb mechanical abilities in repairing a broken piston in a remote area of Kyrgyzstan.

Technical Report

Introduction

Background: Kyrgyzstan is located in Central Asia and borders Kazakhstan to the north, China to the east, and Uzbekistan and Tajikistan to the west. The country has a total area of 198,500 km^2 with a population of about five million people, 65% of which live in rural areas. About 90 % of Kyrgyzstan lies above elevations greater than 1,500 m. Agriculture represents an important sector of Kyrgyzstan's economy and accounts for about 28 % of the total Gross Domestic Product and more than 30 % of total employment. The raising of livestock, especially of horses and sheep, is the dominant agricultural occupation in Kyrgyzstan. Only about 5 % of Kyrgyzstan's land area is under irrigation.

Topography: Glaciers and permanent snowfields cover more than 3 % of the country's total land area. Two great Central Asian mountain systems meet in Kyrgyzstan, namely the Tien Shan and the Pamir Mountain Ranges. These two mountain ranges are geologically separated from each other in southern Kyrgyzstan between the Alai Mountains of the Tien Shan and the Trans-Alai Range of the Pamir Mountains. The Trans-Alai Range, which is the northernmost part of the Pamir Mountains, forms part of Kyrgyzstan's southern border with Tajikistan. The main ridge of the Tien Shan extends along Kyrgyzstan's eastern border with China on a northeastern axis. Victory Peak (known as Pik Pobedy in Russian) is the highest peak in the Tien Shan Range with an elevation of 7,439 m and is located on the Kyrgyzstan-China border in northeastern Kyrgyzstan. A series of mountain chains that form part of the Tien Shan system, including the Alatau ranges, spur off into Kyrgyzstan. Most of these ranges run east to west, but the Fergana Mountains in the central portion of Kyrgyzstan run southeast to northwest. The Fergana Valley in the west and the Chu Valley in the north are among the few significant lowland areas in Kyrgyzstan.

Climate: The country's climate varies by region with a subtropical climate in the Fergana Valley and a temperate climate in the northern foothill zone. The lower mountain slopes have a dry continental climate, as they receive desert-warmed winds from Kazakhstan and Uzbekistan, whereas the highest mountain elevations have a polar climate. In the valleys, the average daily temperature in July is 28°C. In January, daily averages are as low as –14°C. Conditions are much colder at high elevations, where in July the average daily temperature is 5°C and in January is –28°C. Precipitation averages between 100 and 500 mm in the valleys and from 180 to 1,000 mm in the mountains.

Water resources: Kyrgyzstan is covered by a dense network of more than 30,000 rivers and streams that arise from accumulated snow and glaciers in the high mountains. In the Tien Shan Mountains alone there are more than 4,400 glaciers covering 5,168 km^2. The largest rivers in Kyrgyzstan are the Naryn, Chu, Chatkal, Sarydjaz, and Talas Rivers. About 76 % of Kyrgyzstan is comprised of the watershed that feeds the Aral Sea Basin, 11 % that feeds the watershed of Issyk-Kul Lake, 12 % that feeds the Tarim Basin, and 0.3 % that feeds Balkhash Lake. There are more than 2,000 lakes that cover about 7,000 km^2 in Kyrgyzstan. The largest lake in Kyrgyzstan is Lake Issyk-Kul, which is the second largest high-altitude lake in the world and is famous for

its magnificent scenery and unique scientific interest. Lake Issyk-Kul is situated in the northern Tien Shan Mountains, bordered on the north by the Kungey Alatau (with elevations up to 4,771 m) and on the south by the Terskey Alatau (up to 5,216 m). The lake has a length of 182 km, a width of up to 61 km, a surface area of 6,280 km^2, a maximum depth of 702 m, and a volume of 1,738 km^3. Lake Issyk-Kul derives its name from a Kyrgyz word for "hot lake," alluding to the fact that it does not freeze during the winter. The Lake Issyk-Kul Region has a rich flora and fauna that contains more than 4,000 plant species, of which 1,400 are endemic to the area. To conserve the unique biodiversity of this Region, the Issyk-Kul Biosphere Reserve was established in September 1998.

Biodiversity: More than 4,500 species of higher plants are reported to exist in Kyrgyzstan. Diversity of flora in Kyrgyzstan is determined primarily by altitudinal zonation and slope exposure. Slopes with different exposure create different microhabitats, which have encouraged the development of considerable genetic diversity. Steppes, meadow-steppes, meadows, shrublands, and forests are found on northern slopes. Southern slopes with their hot, dry exposure do not typically have zones of forests and alpine meadows. Various floral provinces occur in Kyrgyzstan, including Central Asian, Indian and Himalayan, Northern and Front Asian, Tien Shan, and Alai. About 1,600 species within Kyrgyzstan's flora have economic value including about 450 forage species, 200 medicinal species, and 50 species used for food. Steppe ecosystems prevail in low-lying valleys and low mountain foothills. Meadows, forests, and shrubland ecosystems occur in middle mountain zones, while alpine meadows, cushion plant communities, and alpine tundra occur in the high mountain zones.

Natural forests in Kyrgyzstan are composed of more than 120 woody tree species. The forests are mainly comprised of spruce (*Picea schrenkiana*) on the northern ranges of the Tien Shan. Pistachio (*Pistacia vera*) and almond stands (*Amygdalus communis*) grow in the drier areas protected from the northern winds of the western Tien Shan. The genetic center of walnuts is in the more humid areas in the south, and *Juglans regia* is the dominant walnut species. Apples (*Malus* spp.) and maples (*Acer* spp.) grow in the walnut understory. Walnut and fruit tree forests comprise an area of more than 600,000 hectares and are the largest of this forest type in the world. Ancient forests of wild walnut trees are found on lower mountain slopes. Various species of juniper (*Juniperus* spp.) grow on the dryer mountainsides in both the north and south. Maple, poplar-willow, and birch forests occur in Kyrgyzstan, although the most widely spread forest types include spruce, juniper, and nut-fruit tree forests. Rivers and lakeshores in the valleys have dense thickets of elm (*Ulmus* spp.), poplar (*Populus* spp.), reeds, and shrubs.

Kyrgyzstan has a very rich biodiversity for its size comprising about 2 % of the world's flora and 3 % of the world's fauna. A range of endemic plant species can be found in Kyrgyzstan, such as tulips and onions, and a wide range of wild relatives of fruit and nut trees. The spectacularly varied terrain and climate provide for a diversity of habitats, from rocks and glaciers, to forests, pastures, steppe, and deserts creating some 22 ecosystems in Kyrgyzstan (Table 1).

Table 1. List of Kyrgyzstan's 22 diverse ecosystems (Strategy and Action Plan to Preserve Biodiversity, Ministry of Ecology and Emergency Situations, 1998).

Type of ecosystem	Area (km^2)	Percent of total country area
Fir forests	2,772	1.39
Juniper forests	2,680	1.35
Broad-leaved forests	464	0.23
Tugai	226	0.14
Small-leafed forests	711	0.36
Middle-altitude deciduous shrubs	970	0.48
Middle-altitude petrophilic shrubs	2,317	1.17
Savannoides	6,081	3.06
Amygdaloides and pistachios	182	0.09
Nivalic and subnivalic belt	11,527	5.81
Cryophilic meadows	27,242	13.72
Cryophilic steppes	21,413	10.79
Cryophilic deserts	1,911	0.96
Middle-altitude meadows	8,764	4.42
Middle-altitude steppes	17,643	8.89
Middle-altitude deserts	2,543	1.28
Mountain boghara	2,791	1.41
Foothill steppes	823	0.41
Foothill deserts	8,768	4.42
Petrophilic foothill shrubs	181	0.09
Lakes and swamps	393	0.19
Cultivated land	12,475	6.28
TOTAL	132,877	66.94

Trip Details

Targeted species: Species of *Poa, Agrostis, Festuca, Koeleria, Puccinellia,* and possibly other genera from Kyrgyzstan's flora have potential for low-maintenance turf. Kyrgyzstan has a large number of *Poa* species in its flora with 22 taxa, possibly representing a center of diversity for *Poa*. Consequently, collections of *Poa* from Kyrgyzstan likely contain a large degree of genetic diversity. Accessions of *Poa* from Kyrgyzstan probably have been exposed to heavy grazing pressure for thousands of years and, therefore, likely have developed tolerance to grazing, which would make them ideal candidates for clipping tolerance traits. Other important characteristics include seedling establishment, production, and persistence of high quality turf under conditions of low precipitation, minimal fertility, salinity, and cold temperatures. The steppes and mountains of Kyrgyzstan are rich in grass species and genera, mostly of cool-season grasses of the subfamily Pooideae, particularly of tribes Poeae (including Aveneae), Triticeae, and Stipeae. Considerable molecular variation has been documented for collections of *Poa pratensis* from Eurasia with a good number of chloroplast types in eastern Europe and novel types in Central Asia. Based on evaluations of *Poa* collections from other countries in Central Asia, Kyrgyzstan would be expected to have considerable diversity in the *Poa pratensis* species complex. Some forms such as subsp. *pruinosa* and *P. tienschanica* are probably somewhat salt tolerant and could be useful for turf applications where *P. pratensis* does not usually thrive. The mountains of Kyrgyzstan have 21 other species of *Poa* including *Poa tibetica* (known for its salt tolerance) and various natural hybrids with *P. pratensis* probably exist.

Objectives: Our main objective was to collect seed of grasses in genera of *Poa, Agrostis, Festuca, Koeleria,* and *Puccinellia,* which are known to have potential for low-maintenance turf applications. Characteristics that we were interested in included persistence of high quality turf under conditions of low precipitation, minimal fertility, salinity, cold temperatures, and grazing. A secondary objective of our trip was to collect seed of various grass and legume species with potential for forage or conservation applications when opportunities presented. Another goal was to collect herbarium voucher specimens for use at the Smithsonian Institution with duplicates for other institutions. A final objective was to preserve green leaves of *Poa* species in silica gel packets for future DNA analyses.

Logistical Arrangements: Kanat Samsaliev from the Kyrgyz Institute of Livestock, Veterinary, and Pastures was the in-country coordinator of our trip. Kanat conferred with other scientists concerning the best collecting routes. Kanat and his father (Amantai) obtained the required travel clearances and collecting permits from the Central and Provincial Governments and arranged transportation, lodging, and other logistics for the collection trip. Travel within Kyrgyzstan was with two four-wheel drive UAZ vans (rented with drivers). We brought along necessary collecting equipment and supplies including seed envelopes, global positioning system (GPS), and other miscellaneous supplies. In addition, we purchased various collecting, camping, and cooking gear in Bishkek and countryside markets. Prior to our trip, Maryann Loftus made arrangements for the necessary permits and alerted Homeland Security officials concerning importation of our seed collections and herbarium specimens into the U.S.

Collection Itinerary and Route (Figure 1)

31 July 2006: Unfortunately, at the last minute Pulkovo Airline canceled the airline tickets for Vladimir Chapurin and Sergey Shuvalov for flights from St. Petersburg, Russia to Bishkek, Kyrgyzstan. After numerous telephone calls to secure new airline reservations, receive approvals, and purchase airline tickets, Doug Johnson was given one-time authority from Mr. Steve Helmrich (Chief Financial Officer, USDA-REE, Washington, DC) to use his personal credit card to buy airline tickets for Vladimir Chapurin and Sergey Shuvalov for their flights from Moscow to Bishkek.

1-3 August: With much relief, Doug Johnson, Rob Soreng, Vladimir Chapurin, and Sergey Shuvalov met at the Sheremetyevo International Airport in Moscow, Russia and flew together to Bishkek. Kanat and Amantai Samsaliev met us at Manas International Airport in Bishkek. We were taken to Amantai's farm located near the airport, where we ate breakfast and deposited our camping and collection gear. We were transported to our hotel (Hotel Kazakhstan) and had a badly needed rest after our all-night flight to Bishkek. In the afternoon, we prepared lists of needed camping and collecting supplies, discussed trip financing, went over collecting protocols, and finalized the collecting route.

3-4 August: We met the Director of the Kyrgyz Institute of Livestock, Veterinary, and Pastures (Dr. Rysbek Nurgaziev). We discussed our trip with him, and he indicated his support for our collection trip. We made arrangements to rent two four-wheel drive UAZ vans (and drivers) for our trip. Based on lists prepared the previous day, we purchased food, camping, and collection supplies at Bishkek markets and made final preparations for our trip.

5-9 August: We left Bishkek at 2:30 pm on 5 August and proceeded east through Tokmak to the southern slopes of the Zaliisky Alatau in the Kemin Region of Chu Oblast. We then traveled east-northeast and followed the Kechi-Kemin River through Ak-Tyuz Settlement to an area just below an abandoned uranium mine (Ak-Tyuz Mine). We then followed the Ger-Tabygy River through Boroldoy Settlement. Our route then took us south and then east through Rybachye to Lake Issyk-Kul. We traveled east between the shores of Lake Issyk-Kul and the southern foothills of the Kungey Alatau through Cholpon-Ata. We then traveled north through Kechi-Ak-Suu Canyon where we entered the Kechi Ak-Suu Ecological Reserve (now a heavily grazed area) and eventually reached a point about 8 km south of the Kazakhstan border. We then collected in the northern plains of Lake Issyk-Kul and reached Tyup on the afternoon of 9 August. (59 collections)

10-13 August: After leaving Tyup, we traveled south and west to Przhevalsk, where we made a brief stop at the N.M Przhevalsky Museum. We proceeded west and south and collected on the northern slopes of the Terskey Alatau in the Jeti Oguz and Ton Regions of Issyk-Kul Oblast. We made collections in the red-rock area of Jeti Oguz Valley, the Saruu Gorge above Saruu Hot Springs, Barskoon Valley, and the southern shores of Lake Issyk-Kul. (55 collections)

14-16 August: We traveled west to Kochkorka and then south to areas that included the valleys along the Joon-Aryk and Kara-Unkur Rivers in the Kochkorka and Tien Shan Regions of Naryn

Oblast. We then traveled south through Naryn and collected along the southern slopes of the Terskey Alatau and northern slopes of the At-Bashy Range in At-Bashy Oblast. We arrived in Naryn at 2:00 pm and stayed overnight in hotels there, where we washed clothes, enjoyed hot showers, slept in beds, and ate prepared meals. (54 collections)

17-19 August: From Naryn, we traveled north to Kazan-Kuygan and then turned west into the Tien Shan Region of Naryn Oblast. We collected between the Jergetal and Son-Kel Rivers. On 18 August, one of our four-wheel drive UAZ vans suffered a broken piston in a remote area near Son-Kel Falls. Kanat and our two drivers disassembled the engine, drove four hours to Naryn, bought the needed engine parts in Naryn, and after a four-hour drive returned to our campsite along the Son-Kel River at midnight. The next day the needed repairs were made, and by 4:00 pm we resumed our trip. We collected along Son-Kel River Pass and on the high steppe areas surrounding Lake Son-Kel. We then descended off the high-steppe area of Lake Son-Kel on the evening of 19 August. (38 collections)

20-22 August: We proceeded northwest through Chayek and Kyzyl Oy along the Dzhumgal River Valley in the Dzhumgal and Dzhaiyl Regions of Naryn and Chu Oblasts, respectively. We then made collections along the rugged Kokomeren River Gorge enroute to Suusamyr Valley. In Suusamyr Valley we made collections at several locations along the northern slope of the Suusamyr Range. We crossed the Suusamyr River at the historical Kazakh Bridge, which Kazakh herders used formerly to cross into the Suusamyr Range to graze their herds. We also used horses (owned by Tuganbai's uncle) to cross the Suusamyr River to collect in lightly grazed bench areas above the river. On the night of 21 August (our last night in the field), we ate a traditional Kyrgyz meal (bishbarmak, with freshly slaughtered goat and all the trimmings) at Tuganbai's uncle's yurt. On 22 August we made final collections in Suusamyr Valley on the southern slopes of the Kyrgyz Alatau and periodic collections both ascending and descending to/from Tuz-Ashuu Pass in the Kyrgyz Alatau. We arrived at Hotel Kazakhstan in Bishkek at 6:00 pm. (60 collections)

23-26 August: At Amantai Samsaliev's Farm and at Hotel Kazakhstan in Bishkek, we cleaned, weighed, and split the seed collections between the U.S., Russia, and Kyrgyzstan. We verified species names and prepared a list with field collection numbers, Latin species names, and seed amounts for each collection. Seed packets and herbarium specimen sheets were delivered to the Department of Chemistry, Plant Protection, and Quarantine Service in Bishkek for inspection. Export Permits for seed and herbarium specimens and Phytosanitary Certificates were obtained.

27 August: Russian and U.S. team members departed Bishkek for their respective home destinations, and the seed and herbarium collections were checked as luggage. Doug Johnson delivered the U.S. portion of the seed collections to Homeland Security inspectors at JFK International Airport in New York where inspectors forwarded them to the USDA Plant Germplasm Quarantine Center in Beltsville, Maryland for processing. Rob Soreng presented his herbarium specimens and leaf samples in silica gel packets for inspection at Dulles International Airport where they were inspected and released for transport to the Smithsonian Institution in Washington, DC where they were frozen at -20^{o}C for one week. Sergey Shuvalov and Vladimir

Chapurin presented their seeds and herbarium specimens for inspection at the Sheremetyevo International Airport in Moscow. The Russian portion of the collections was brought back to the N.I. Vavilov Research Institute of Plant Industry in St. Petersburg, Russia.

Collections: Our collection route traversed more than 2,000 km (Figure 1) and covered a broad diversity of ecosystems and plant communities in eastern Kyrgyzstan. We made a total of 266 collections (Table 2) covering a wide range of grass and legume species throughout Chu, Issyk-Kul, and Naryn Oblasts of Kyrgyzstan. This included 159 collections of various species that hold promise for low-maintenance turf applications including *Poa* (65), *Festuca* (18), *Agrostis* (25), *Phleum* (10), *Avenula* (7), *Trisetum* (5), *Puccinellia* (3), *Koeleria* (2), and 24 other grass collections. When available, seeds of various forage grasses were collected including *Elymus* (25), *Bromus* (9), *Agropyron* (4), and *Leymus* (3). Of particular note were high-elevation collections of *Dactylis glomerata* (12), which may hold promise for cold tolerance. Opportunistic seed collections of various forage legumes were also made including *Trifolium* (11), *Medicago* (5), *Melilotus* (5), *Onobrychis* (4), *Vicia* (4), *Hedysarum* (3), and *Lathyrus* (3).

After processing of the seed collections at the Plant Quarantine Center in Beltsville, Maryland, the U.S. portion of the seed will be shipped to Logan, Utah where the seed will be given a final cleaning. Small portions of the seed will remain at Logan for evaluation in breeding programs at the USDA-ARS Forage and Range Research Lab and Utah State University for their potential use in low-maintenance turf, forage, and conservation applications in the western U.S. The bulk of the U.S. portion of the seed will be sent to the Western Plant Introduction Station in Pullman, Washington, for incorporation into the U.S. National Plant Germplasm System. These collections will be available for research to scientists around the world. The U.S. herbarium specimens will be prepared as vouchers for use at the Smithsonian Institution, and duplicate specimens will be sent to other herbaria. The leaf samples collected in silica gel packets will be subjected to phylogenetic analysis based on DNA sequence data. The Russian portion of the seed and herbarium specimens will be processed and curated at the N.I. Vavilov Research Institute of Plant Industry in St. Petersburg. The Kyrgyzstan portion of the seed collection will be curated through the Kyrgyz Institute of Livestock, Veterinary, and Pastures.

Benefits to U.S.: With the expanding population in the U.S., demand for water is increasing for human consumption, recreational uses, landscaping, and industrial purposes. This is especially true in the arid and semiarid western U.S. where water resources are limited due to low precipitation and high evaporative rates. Typical high-input turf species for expansive lawns, parks, and golf courses are becoming increasingly scrutinized for their high water consumption. Costs for water usage has increased dramatically the last few years and will likely increase further in the future. In addition, water restrictions are being imposed during the hot, dry summer months in many metropolitan areas of the western U.S. As a result, homeowners, golf course managers, and park superintendents are actively seeking alternatives to reduce water consumption. Xeriscaping is becoming more popular, and there is considerable interest in replacing high-input turf species with low-maintenance species.

Our collections from Kyrgyzstan will expand existing low-maintenance turf germplasm by

adding germplasm that has tolerance to low temperatures, soil salinity, drought, and other adverse growing conditions. Also, ecotypic diversity for response to clipping most likely exists in this germplasm because plants there have been exposed to intensive grazing by wild and domesticated herbivores for thousands of years and likely have been genetically modified through natural selection. As a result, this collected germplasm will be beneficial for turf improvement programs in the western U.S. and possibly other parts of the U.S. Collected materials also have potential for biotechnology applications to improve insect and disease resistance, and drought and salinity tolerance of important crop species. Incorporation of collected germplasm into the U.S. National Plant Germplasm System will allow use by scientists in the U.S. and throughout the world, and will ensure preservation and conservation of this unique germplasm.

Benefits to Kyrgyzstan and Russia: Our collections will add important germplasm to the Kyrgyz and Russian Genebanks. Immediate conservation of this germplasm is important because increasing animal numbers in Kyrgyzstan threaten to limit seed availability of these unique germplasm pools. These collections will make important germplasm available to Kyrgyz, Russian, and other Asian scientists in their breeding and improvement programs, eventually leading to improved cultivars for low-maintenance turf. Interactions among team members from USDA-ARS, Smithsonian Institution, N.I Vavilov Research Institute of Plant Industry, and Kyrgyz Scientific Research Institute of Livestock, Veterinary, and Pastures strengthened professional ties. In addition, exchange of information among team members during the collection trip assisted in transferring the latest information and technology concerning germplasm collection, preservation, and utilization; plant breeding and selection; low-maintenance turf; and rangeland improvement.

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Table 2. Species and numbers of collections (Kyrgyzstan, Aug. 2006)

Agropyron cristatum (4)
Agrostis gigantea (24)
Agrostis stolonifera (1)
Allium hymenorrhizum (1)
Allium polyphyllum (1)
Allium spp. (5)
Alopecurus pratensis (2)
Anthoxanthum nitens (2)
Arrhenatherum elatius (1)
Avenula hookeri (3)
Avenula pubescens (4)
Bromus inermis (9)
Calamagrostis pseudophragmites (1)
Dactlyis glomerata (12)
Deschampsia caespitosa (2)
Elymus dahuricus (7)
Elymus dentatus (1)
Elymus repens (7)
Elymus schrenkianus (3)
Elymus sclerophyllus (2)
Elymus sibiricus (5)
Festuca alatavica (1)
Festuca rubra (5)
Festuca valesiaca subsp. kirghizorum (1)
Festuca valesiaca subsp. pseudodalmatica (1)
Festuca valesiaca subsp. valesiaca (10)
Hedysarum spp. (3)
Helictotrichon tianschanicum (2)
Hordeum bogdanii (1)
Hordeum brevisubulatum (2)
Koeleria macrantha (2)
Lathyrus pratensis (2)
Lathyrus tuberosus (1)
Leucopoa karatavica (2)
Leymus paboanus (1)
Leymus secalinus (2)
Medicago falcata (5)
Melica transsilvanica (3)
Melilotus albus (1)
Melilotus officinalis (4)
Onobrychis vicifolia (4)
Phleum alpinum (1)
Phleum phleoides (9)
Poa albertii (1)
Poa alpina (1)
Poa bucharica (2)
Poa lipskyi (1)
Poa lipskyi X Poa pratensis hybrid (1)
Poa palustris (2)
Poa pratensis (38)
Poa pratensis hybrid (1)
Poa pratensis mix (1)
Poa remota (1)
Poa supina (1)
Poa tibetica (2)
Poa trivialis (1)
Poa urssulensis (9)
Poa versicolor (2)
Poa versicolor subsp. relaxa (1)
Psathyrostachys juncea (1)
Pseudoroegneria cognata (1)
Ptilagrostis malyschevii (1)
Puccinellia glauca (1)
Puccinellia hauptiana (1)
Puccinellia tianschanica (1)
Schedonorus arundinaceus (2)
Schedonorus pratensis (11)
Stipa capillata (1)
Stipa caucasica subsp. desertorum (1)
Trifolium fragiferum (1)
Trifolium pratense (8)
Trifolium repens (2)
Trisetum sibiricum (3)
Trisetum spicatum (2)
Vicia cracca (1)
Vicia spp. (3)

Total = 266

Figure 1. Travel route and collection sites in Kyrgyzstan.