Leader with Associates Cooperative Agreement Number 306-A-00-06-00501-00
Under Leader Award LAG-A-00-00047-00

APPENDIX 4

Rangeland Assessment in Wakhan

By

Wildlife Conservation Society
Rangeland Assessment Team

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THE WAKHAN CORRIDOR: RANGELANDS, TRAINING AND ASSESSMENT

INTRODUCTION

The rangeland analysis of the Wakhan in 2008 was designed to improve the supervised classification, supplement transect information on plant communities, supplement biomass information for estimating forage production of different plant communities, measure pH and electrical conductivity of major plant communities, improve plant species information, establish additional monitoring plots, and develop additional information on rangeland degradation. During the previous two summers the rangeland survey team worked in several of the major Pamir valleys and the team was concerned that the work in the major valleys may be in areas with greater livestock use and degradation. As such, the rangeland team specifically went into some of the smaller side valleys in the Pamir to observe conditions. The rangeland team concentrated on a rapid rangeland assessment and mapping of broad rangeland types through these areas and continued to establish permanent transects for monitoring vegetation change. A total of 28 plots were established in July/August 2008. On these plots photo points were established and physiographic measurements, plant cover, standing crop and soils samples were collected for determining salinity levels and soil pH. Soil samples were collected from the surface and subsurface at randomly located points in the rangeland plots. A total of 65 soil samples were placed in paper bags, air dried and transported back to Kabul for analyses. For 20 of these sites, a more detailed analysis of rangeland condition was determined.

In this report the general findings of the 2008 field season are described, but the major findings of the rangeland study will be presented in a final report for the rangeland assessment of the Wakhan Corridor, including work from 2006-2008. As stated in previous reports, a rapid reconnaissance methodology was used to observe as much of the area as possible to help ensure that most the rangeland types have been documented. It is believed that it is important to observe most of the area to evaluate areas important for pastoralists and areas where there may be competition for forage between livestock and wild ungulates. These rangelands are the basic resource for the livestock and wildlife that have used the Wakhan Corridor for centuries. There is no doubt that livestock grazing has impacted these rangelands and in many areas overuse by livestock has decreased site productivity. Other human use has also impacted rangelands by removing shrubs for fuel (in some areas minor use of trees was observed), cutting of hay, use of “peat” from *Carex* meadows, irrigation ditches, and (in a few areas) ditches for draining or diverting wetlands.

This report is separated into four major sections. Initially, a brief discussion of training of the rangeland assessment team is provided. Second, there is a general overview of the areas traveled and some notes on general observations. Third, is an overview of plots measured mainly to supplement plant community information for the Wakhan rangeland community analysis As stated previously, some of the plot information was collected to determine if some smaller and somewhat more isolated valleys were in similar grazed conditions as the major valleys. This was done because most plant community information had been collected in the larger valleys in 2006-

07. The supplemental plant community information was also collected to improve the supervised plant community classification developed in 2008. A fourth section describes some rangeland degradation processes, mostly with photo descriptions, on some important rangeland community types.

RANGELAND FIELD TRAINING

Rangeland training consisted of training two Wakhi from local villages to measure rangeland site characteristics. The rangeland assessment team also consisted of a Wakhi from Pakistan (Ph.D. student studying plant chemistry) to help with Wakhi guides and Wakhi field technicians. By 15 July we were in the Wakhan and worked on rangeland analyses for 23 days. The major training consisted of development of skills with a compass (determination of aspect, slope and direction), in the use of a global positioning system (GPS) to locate sites (elevation and geographic coordinates and to be able to return to the sites), establishment of transects (including photo methods), plant identification skills, determination of above-ground biomass and discussion of rangeland degradation attributes. One Kabul student, worked as a rangeland technician from March to July, and helped with summarizing data from 2007 and participated in field work in Bamian Province in May and June. Skills learned by the student included work in spreadsheets, word documents, and report preparation. Although this technician did not join the Wakhan expedition with the rangeland team, he helped with logistics and preparing equipment. This student received a job with the Ministry of Agriculture in mid July and it is hoped that his training better prepared him for a career with the Ministry of Agriculture.

GENERAL DESCRIPTION OF ROUTES AND RECONNAISSANCE

The travel routes and transect site location of the rangeland team are shown in figure 1. The rangeland team completed a rangeland reconnaissance along the main road in the upper Wakhan from Goz Khun to Sarhad-e Broghil. In this work, major plant communities were identified by mapping these plant communities on Landsat map sheets. This information was then added to the rangeland GIS and also used in the supervised plant community classification. Some rapid reconnaissance plots were also done in the lower Wakhan, from Qila-e Panja to Khandud, along the main road.

The major field work was associated with plant community transects and the measurement of standing crop (above-ground plant biomass) in several mountain valley areas leading into the Big and Little Pamir. In the following paragraphs the rangeland team's route is described by using streams to describe the general route. Information on general field notes are part of the rangeland GIS. General field notes often include an associated photo within the rangeland GIS (Fig. 2). For example, the rangeland team recorded locations of pictographs (Appendix 1), photographed the pictographs, and placed the information in the rangeland GIS.

The rangeland team initiated the major field survey in 2008 beginning at Sarhad-e Broghil and traveling to

Bozai Gumbaz using pack animals. This is a major trail, referred to as the "Kashch Goz High Route[1]." The trail begins east along the mountain ridges above the Wakhan River to Borak. At Borak the trial is to the north above the stream Darya-e Badjgaj and then over a pass into the Darya-e Shpodigis stream valley. Near the upper valley the trail turns mostly east until it crosses over the 4890 m pass at Kotal-e-Shpodgis (Uween e Sar). After the pass the trail is along the upper Darya-e Warm and is mostly a southeast trail until the trail turns to the east toward the 4600m pass (Kotal-e-Aqbelis). After the pass the trail is mostly again a southeast route along a stream (Aqbelis). Transects for plant community work were established in the Kasch Goz area and up some of the valleys off of the main trail close to the border with Tajikistan (Qirtshin Aq Djelgha and ZorAq Djelgha.) as well as in the Bozai Gumbaz area (in figure 1 transect locations are shown).

The rangeland team returned along about the same route until crossing to the "Kotal-e-Shaur Route." However, the range team leader inspected several smaller valleys in upper Darya-e Warm and upper reaches of Darya-e Shpodgis to rock/ice level and almost to the Tajikistan border to determine if these smaller valleys were being grazed by livestock as intensively as the main valley. In general, all valleys inspected in this area were heavily used by livestock. The valley of Darya-e Warm is one of the most overgrazed valleys, and it has not been determined why this is true. However, it is a major route into the Little Pamir.

A few kilometers west of Kotal e Aqbelis a new Wakhi camp was being constructed (Fig. 3). The rangeland team leader was told that this new camp was being established to ensure control by Wakhi rather than by Kirgiz. As this area currently receives overuse by livestock the new camp is likely not good for future rangeland conditions. Also, if what was told to the range team leader was true, it provides some evidence of conflicts associated with pasture use in the area.

The rangeland team crossed west over the pass Kotal-E Qarbel (4820 m) and into the upper Darya-e Badjgaz (Darya-e Shaur). Additional plant community descriptions were collected in the upper Shaur stream valley where rangeland conditions were better than in many of the other major valleys reconnoitered. The route proceeded south until crossing Darya-e Ptukhshur where the team then moved west along a tributary until again moving south over an unknown pass. After the pass the rangeland team traveled down the Darya-e Sarhad until reaching Sarhad-e Broghil. Field notes of these reconnaissance trips, photos and transect data have been included in a rangeland GIS and this information is not detailed in this section. During these reconnaissance trips the WCS range team established 28 transects with spatial coordinates and photos to be used as potential permanent photo points and for establishing plant community information. On these sites standing crop (kg/ha) was determined to estimate forage production and thus a general guide to grazing capacity for future analyses. A summary of the transect information will be presented and discussed in the section "Rangeland Plant Community Analyses."

[1] These routes are described by Mock and O'Neil (2005) and these routes are along major trails into the Big and Little Pamir.

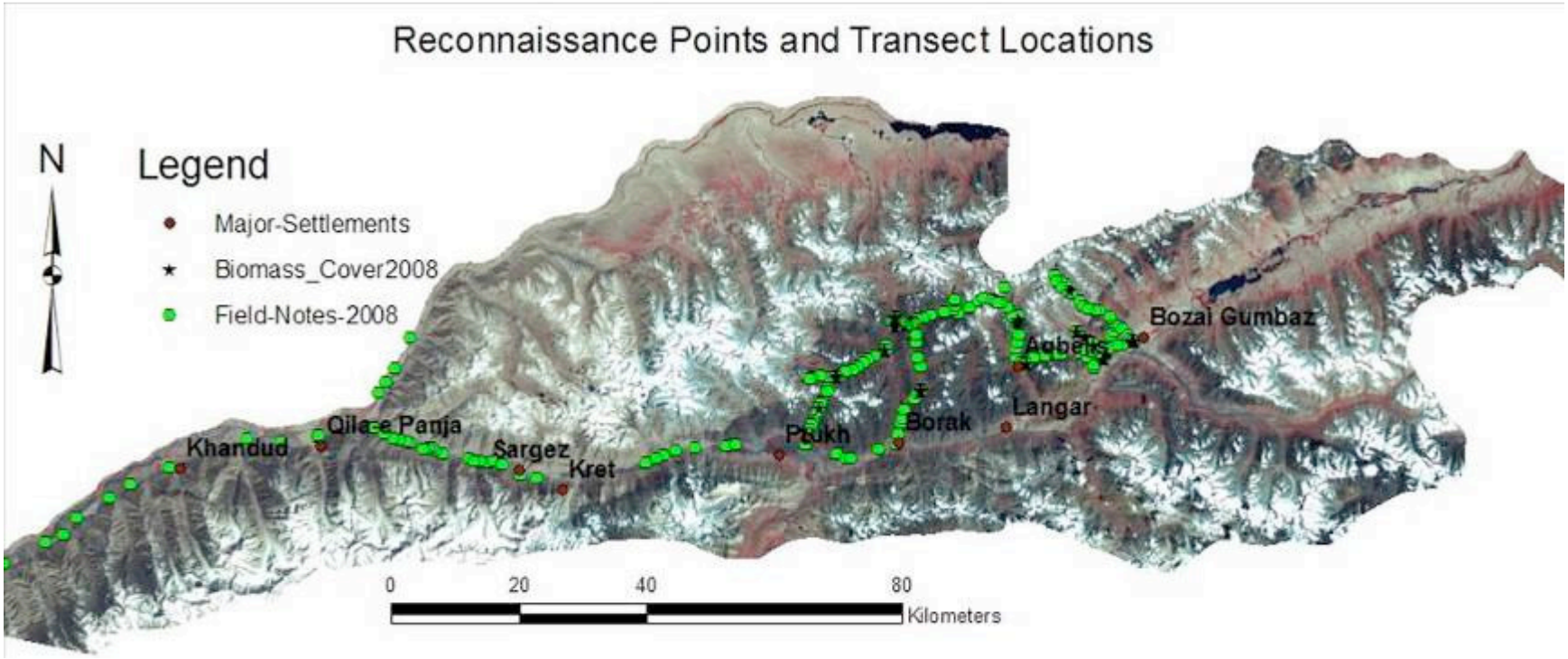

Figure 1. Reconnaissance points (field note points shown in green) and transects locations (shown as a star and plots for biomass and cover) for 2008 Wakhan rangeland reconnaissance.

All points with photographs are hyperlinked (see figure 2) in the rangeland GIS. Base image is Landsat ETM+ image with 4,3, 2 band combination for red, green and blue respectively. Snow and glaciers appear white and areas of green vegetation are red. Water is black.

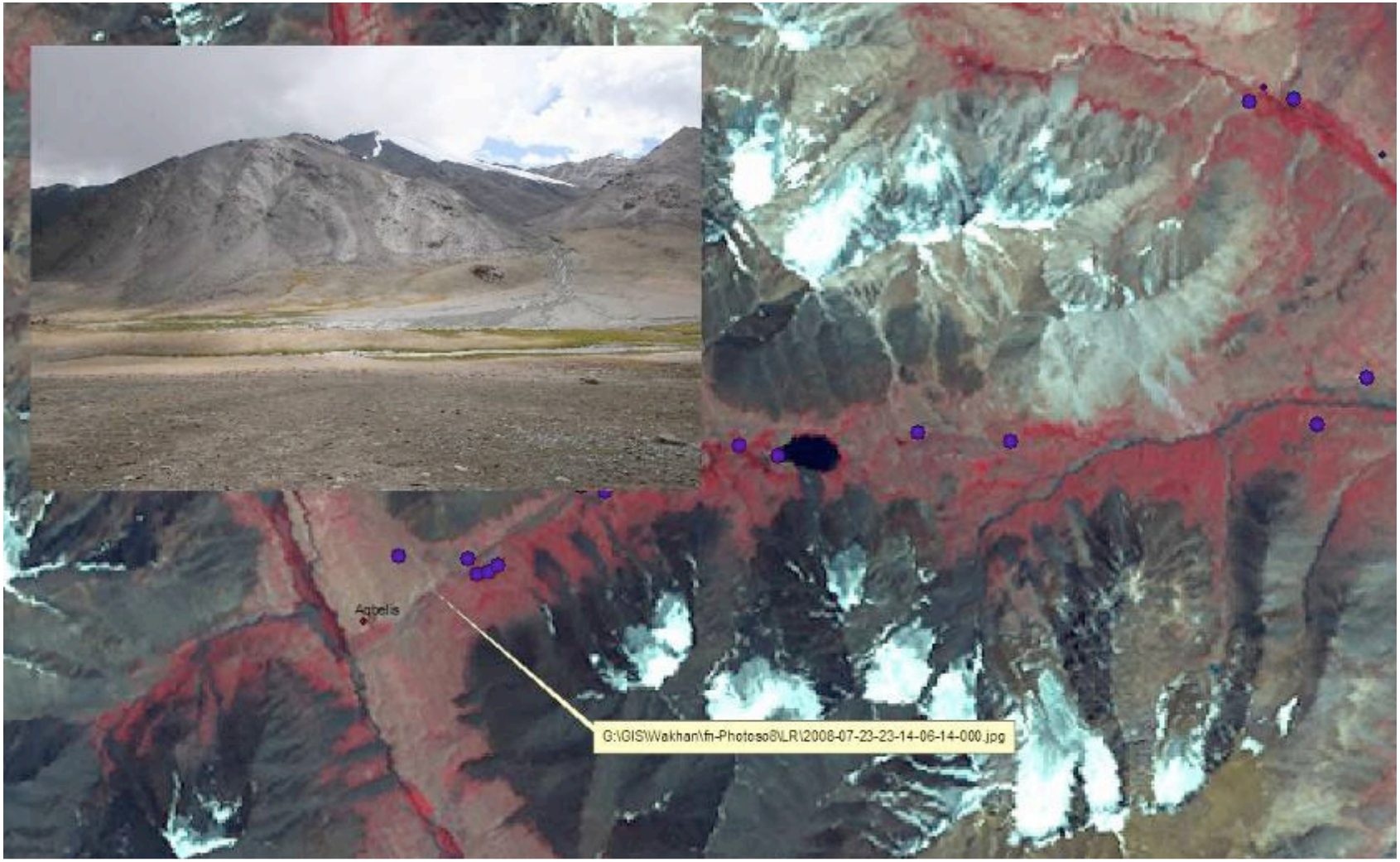

Figure 2. Depiction of hyperlink between field note points and photos.
Data regarding field notes and transects are included in the rangeland GIS.

Figure 3. Photo of new camp being constructed west of Aqbelis pass.
Field Notes id: (37.1264384N, 73.8367801E. 29-JUL-08 12:32:42, 4494m). Photo 2008-07-29-12-09-000.jpg.

RANGELAND PLANT COMMUNITY ANALYSES

Data on plant communities and rangelands of the Wakhan have been reported in 2006 and 2007. In 2008, the WCS rangeland team concentrated on developing additional information on plant communities, some soil information, and additional standing crop information. As stated in previous reports, the rangelands of the Wakhan have formed over time under the influence of the geology, soils, climate, and animals that use these rangelands. The mountain landscape is one of high elevation plateaus, steep slopes (with scree slopes prevalent), alluvial fans, both broad and narrow, and some relatively large valleys. With the dynamic nature of the environment, rangelands are continually changing and the plant communities of the Wakhan vary both in time and space. The climate is cold and relatively dry so that these rangelands are dominated by a cold, semi-desert type at mid and lower elevations and alpine and cushion plant communities at higher elevations below the nival (rock and ice) zone[2] where ice formation and frost heaving of soils may impact plant communities. "Green strips" and meadows form where there is additional water from melting glaciers, along streams, and sub-irrigated areas. Soils are generally poorly developed, and as associated with the mountain building processes, are relatively young soils with little horizon development.

A major objective of the rangeland analysis of the Wakhan in 2008 was to improve data on plant community standing crop for improved estimation of plant community characteristics and for development of grazing capacity estimates.

[2] Breckle (1971) describes the nival zone as occurring at 4900 m on northern exposed slopes and 5300 to 5400 m for southern exposed slopes in northern Afghanisan. This seems to be accurate for much of the Wakhan.

The rangeland team established 28 plots where standing crop data, physiographic characteristics (slope, aspect, elevation, landform), cover (soil, rock and plants by species), and soil pH and electrical conductivity were determined. These sites are also identified by latitude and longitude, included in the Wakhan Rangeland GIS and are developed for use as permanent photo plots for future monitoring. Each transect site has a number of identified photos for each plot/transect (Appendix 2). In the following sections the methods and results of the rangeland team's 2008 work in the Wakhan is summarized. Included is a brief summary and management implications.

Methods

Rangeland plots were established using a subjective selection of sites where it was determined that plant community information was needed. Once a site was selected, a transect was placed on the site in an area that was representative of the site characteristics. From each transect, the rangeland team established photo-points, plot areas for estimation of cover attributes (plant cover by species, litter, bare ground, and rock), and sites for soil collection for measuring electrical conductivity and pH.

Soil pH and ECe

A total of 65 soil samples were placed in paper bags, air dried and transported back to Kabul for analyses. Soil samples were taken by digging a small pit with a shovel to a depth where rooting activity ceased or to rock. In general, two soil samples were taken at each site and this included soil samples from either two (shallower soils) or three depths (deeper soils). A soil sample was taken near the surface (0- 5 cm) and a second sample was taken from about 10 cm to where rooting activity ceased (where few or no roots observed). In some of the deeper soils a 3rd sample was taken.

Two depth measurements were made for soil pits. One was a rooting depth, considered the deepest depth in which roots were observed. A second depth measurement was recorded as total soil depth. This could be to the C horizon or to any mostly impermeable layer. The data on total soil depth is not considered accurate on sites with deeper soils as our shovel handle continually broke so soil pits often ceased because of difficulty digging in the soils.

The pH and ECe were measured using the ExStik EC500 meter (Extech Instruments). Sample preparation methodology was from USDA Agricultural Handbook 18 using a 1:1 soil to water Ratio- (Soil Survey Manual U.S. Department of Agriculture Handbook No. 18). Soil (5 grams) and distilled water (5 mL) were added to a paper cup (approximately 50 ml volume) and stirred vigorously. This mixture was then allowed to stand without agitation for 30 minutes. After 30-minutes readings of pH and ECe were taken first stirring the solution and then immersing electrodes of the ExStik. The ExStik was calibrated according to the manual with 3 standard solutions. For pH the buffer solution was 4, 7, and 10 pH. For ECe the calibration range used a low, a medium and high range which included solutions of 84 uS/cm, 1413 uS/cm, and 12,880 uS/cm, respectively.

Site and Plant Community Analyses

During our field work the rangeland team established 28 plots to determine different site and plant community characteristics. A transect was established with a latitude and longitude and direction in each plot. Photos were taken of the starting point to the end point and vice-versa with landscape and more close-up photos for allowing the sites to be used as permanent monitoring sites. Data collected at each plot included physiographic characteristics such as slope (%), aspect (degrees), and elevation (meters). Slope and aspect were determined with a compass. Elevation was determined with a GPS

(Garmin 76C). Other site characteristics measured were percentage of bare-ground and rock.

For plant community characteristics canopy cover by species was determined in 0.5 m^2 plots and plots were clipped to determine current standing crop. For standing crop measures all vegetation was clipped to ground level, placed in a paper bag, and weighed with a Pesola spring balance in grams. Green weights were recorded and a minimum 10 g sample of each species was air-dried, and then weighed to allow for green weights to be converted to air dry weights. All weights are therefore on an air-dry basis and reported as kg/ha. Notes on grazing use, land-form, other plant species present but not found in 0.5m^2, and an estimate of site conditions associated with rangeland condition/health were recorded. The WCS rangeland team determination of rangeland condition was a modified health assessment using indicators of rangeland conditions. A U.S. approach to classifying rangeland health attributes is problematic in that there are no reference sites in Afghanistan [3]. However, the procedure does allow for an estimation of rangeland condition and health attributes. The rangeland team chose 20 plots to examine rangeland health attributes in 2008. In categorizing rangeland health in this procedure, it is hypothesized that those sites in "Extreme" and "Moderate to Extreme" departure classes are sites with high degradation and little doubt that rangeland health is compromised. Those sites classified with "Slight to Moderate" and "None to Slight" departure are sites where degradation is not evident and these sites are currently or until recently being grazed at an intensity that allows for sustainable use. The mid class (moderate) is where indicators are not clear and these sites could be degrading or perhaps improving. A site may have most of the indicators showing no evidence of decreased health but if a few indicators were obvious in showing poor health the overall condition of the site was rated as degrading or "unhealthy."

Degree of Use of Sedge Meadows

It is important to know the degree of use of vegetation so adjustments on grazing capacity or management can be made to ensure that overuse of certain types is not occurring. As no ungrazed pastures exist in most areas and no exclosures exist, it has not been possible to provide an estimate of rangeland use. It has been obvious that most sedge meadows and alpine grasslands are heavily used in summer pastures. Estimates of the degree of forage use are difficult, but for sedge meadows the areas often have the look of a "mowed lawn". As such, it was estimated that forage use of sedge meadows in summer pastures was approaching 70%. This high level of use would not be sustainable, but as no ungrazed pastures exist, it was difficult to determine if these estimated use rates were reasonable. The rangeland team continued to attempt to locate areas with reduced grazing pressure and on 27 July 2008, some small areas were located that were protected from most livestock grazing. These areas were then measured using a "paired plot approach" where one pair was unprotected (and grazed) and one pair protected (ungrazed). The "protected" sites were associated with wire that had been used by the Soviets for protecting their base near Goz Gumbaz, and had been left on site. The wire restricted livestock grazing for less than a meter wide and the restriction was not 100%, but it did allow for a comparison between a grazed and ungrazed side by side plots. Our clipped plots were 0.5 m^2 and all clipped material from the plots is reported as kg/ha on an air dry basis. Percent

[3] In the U.S. an Ecological Reference Area (ERA) is needed for site comparisons. The ERA comparisons will be the same site (climate, soils) with information on the natural variability of attributes such as litter cover, different life-forms, rills, bare ground etc. This allows an estimate on "the degree to which the integrity of the soil, vegetation, water, and air, as well as ecological process of the rangeland ecosystem, are balanced and sustained". Ecological sites are not available for Afghanistan so rangeland health estimates were based on subjective judgment of hypothesis of current conditions related to what potential conditions might be based on current climate conditions and this investigator's experience on similar sites.

use was calculated as:

Percent Use = [(Ungrazed plot SC-Grazed plot SC)/Grazed plot SC] * 100

The site location of this utilization measurement was near a stream (Qirtshin Aq Djelgha) and within the riparian zone; however, it was high in the riparian zone and was certainly not as productive as some wet sedge meadows found in the Wakhan. The wire was cut with wire cutters and removed to allow for measurement of the "protected" site. A site very close to the wire, with the same land-form was selected as the grazed "paired-plot".

Results and Discussion

Soil Analyses

For the 65 soil samples the mean pH was 7.3 and varied from 5.7 to 9.7 (Table1). Carex meadows were generally acidic (pH < 6.0), sites with either *Hordeum* sp. or *Kraschenninnikovia ceratoides* were generally basic (pH > 8.0) and *Artemisia-Festuca/Bromus* sites were generally moderately acidic (pH < 6.8). Rooting depth and total soil depth averaged 24 cm and 31 cm, respectively and varied from 11 cm to 69 cm (Table 1). Sites with *Acantholimon* had shallower soils and rooting depth was lower than on other sites.

The mean ECe was 0.57 and varied from 0.05 to 7.66. Only two sites sampled were considered to be approaching salty soils (ECe > 4 ds/m^2). Having few sites with low salinity levels was likely associated with the type of sites sampled as most sites were high mountain sites with good internal drainage; however, as several *Kraschenninnikovia ceratoides* and *Hordeum* sites were measured the low ECe levels was somewhat unexpected. It is likely that calcium carbonates are high in these soils.

Site and Plant Community Characteristics

Mean plot elevation was 4228 m and varied from 3962 m to 4588 m (Table 1). These plots were mostly in summer pastures and represent predominately alpine grasslands, sedge meadows, and *Artemisia* steppe. Grass/Grass-like cover averaged 16% and varied from < 1% to 85% (Table 2). Grass cover varied greatly associated with plant community type, but there is no doubt that grass cover (and more importantly production) is decreased on overgrazed sites. Total forb cover varied from 0 to 50% with forbs increasing on many overgrazed sites. Total vegetation cover (sum of grass and grass-like, forbs, and shrubs) averaged 33% and varied from 2% to 90%. Sites with the lowest vegetation cover were cold desert shrub types (*Artemisia* and *Kraschenninnikovia ceratoides*). Sites with *Kraschenninnikovia ceratoides* generally had higher pH levels and the two lowest cover sites, *Kraschenninnikovia ceratoides* sites, also had elevated soil salinity levels (Table 1).

Table 1. Site characteristics (elevation, aspect, slope), soil characteristics (pH, ECe, rooting depth, and total soil depth) and standing crop (SC) (total, grass, forbs and shrubs) on Wakhan plots established in 2008.

Date	Time	Elevation (m)	Aspect	Slope	pH	Ece (uS)	Rooting depth	Soil Depth	Total SC (kg/ha)	Grass SC (kg/ha) *	Forb SC(kg/ha)	Shrub SC (kg/ha)	Community Type**
20Jul	1600	4093	225	5	6.3	110	43	43	400	380	5	0	Carex meadow
20Jul	1700	4113	225	25	7.8	209	11	22	200	250	0	0	Astragalus/Carex meadow
22Jul	1615	4404	0	0	6.3	117	17	42	nd	nd	nd	nd	Carex meadow/alpine

22Jul	1630	4418	0	0	5.9	98	27	34	nd	nd	nd	nd	Carex meadow/degrading
22Jul	1730	4433	325	1	6.3	216	27	34	nd	nd	nd	0	Degraded Carex meadow
24Jul	1500	4104	120	8	8.2	213	14	23	151	9	0	142	Art/Acan- Stipa/Poa
24Jul	1600	4076	273	4	7.9	242	14	23	198	145	4	49	Art/Acan-Stipa/Hord.
25Jul	1100	4345	190	2	9.1	2176	14	19	228	128	100	0	Astniv/Hordeum
25Jul	1200	4350	45	4	6.7	121	20	20	190	85	105	0	Poa/Neppam/Hordeum
25Jul	1400	4322	220	1	9.7	980	13	23	30	30	0	0	Acantholimon/Hordeum
25Jul	1530	4266	80	1	7.7	142	18	27	73	6	67	0	Artemisia-Acantholimon
27Jul	1140	4588	278	2	7.7	215	30	41	493	335	158	0	Alpine Grassland
28Jul	1500	3962	166	11	8.3	4305	13	23	80	40	0	40	Kralan/Artemisa-Leymus
28Jul	1520	3962	166	11	8.1	245	17	23	130	50	0	80	Art/Kralan-Stipa
28Jul	1535	3967	166	11	8.2	276	19	25	200	50	0	150	Art/Cerlan-Stipa
28Jul	1545	3966	166	11	8.3	6895	17	30	175	50	0	125	Art/Cerlan-Stipa
29Jul	1630	4446	300	2	6.1	161	51	69	400	380	20	0	Carex meadow
29Jul	1700	4450	300	4	7.5	185	15	23	300	150	50	0	Alpine
1Aug	900	4205	284	18	6.6	86	17	20	231	91	105	35	Art-Festuca/Poa
1Aug	1000	4244	278	18	6.4	73	33	38	413	117	209	116	Art-Festuca/Poa
1Aug	1130	4192	240	3	6.0	105	13	20	405	57	149	98	Art-Festuca/Poa
1Aug	1530	4195	260	18	6.7	90	13	20	405	84	222	99	Art-Festuca/Poa
1Aug	1700	4207	286	20	7.1	114	51	58	439	89	276	74	Art-Festuca/Poa
2Aug	1430	4062	86	12	7.1	271	36	36	522	122	247	153	Art/Bromus/Stipa
2Aug	1600	4080	131	16	6.5	105	24	24	619	314	218	87	Art/Bromus/
2Aug	1700	4103	116	28	7.2	136	23	28	402	134	254	14	Art/Bromus/
4Aug	830	4482	22	8	7.5	117	25	41	293	45	248	0	Astniv/Poa
4Aug	945	4490	20	12	6.5	63	30	38	377	8	369	0	Astniv/Potentilla
5Aug	715	4078	80	34	7.4	150	41	41	457	234	223	0	Bromus/Neppod
Mean		4228	174		7.3	628	24	31	300	130	117	47	

* Grass standing crop includes grasses and grass-likes (sedges and rushes).
*Community types are based on dominant cover. Art= Artemisia, Kralan=Krascheninnikovia ceratoides; Acan=Acantholimon; Astniv=Astragalus nivalis. Hord=Hordeum.

Table 2 Ground cover (%) and canopy cover of plots measured in Wakhan in 2008.

Transect Date	Transect Time	Ground Cover (%)			Canopy Cover (%)									Community Type*
		Rock	Litter	BG	Grass	Carices	Legumes	Mints	Other Forb	Total Forb	Low Shrub	Tall Shrub	Total Shrub	
20Jul	1600	0	20	10	2	75	2	0	3	5	0	0	0	Carex meadow
20Jul	1700	15	1	45	6	10	15	0	12	27	2	0	2	Astragalus/Carex meadow
22Jul	1615	10	5	25	5	5	55	10	0	60	0	0	0	Carex meadow/alpine
22Jul	1630	0	5	5	1	90	2	0	3	5	0	0	0	Carex meadow/degrading
22Jul	1730	15	5	40	2	tr	10	0	30	40	0	0	0	Dried Carex meadow
24Jul	1500	2	1	92	1	0	0	0	0	0	2	4	6	Art/Acan-Stipa/Poa
24Jul	1600	2	3	88	4	2	0	0	0	0	0	1	2	Art/Acan-Stipa/Hordeum
25Jul	1100	3	7	36	14	2	31	0	5	37	9	0	9	Astniv/Hordeum
25Jul	1200	40	1	55	5	0	1	2	2	5	0	0	0	Poa/Neppam/Hordeum

25Jul	1400	2	1	90	1	0	0	0	0	0	9	0	9	Acantholimon/Hordeum
25Jul	1530	7	1	86	0	0	0	0	0	0	8	6	14	Art-Acantholimon
27Jul	1140	26	9	35	17	8	3	0	8	11	0	0	0	Alpine Grassland
28Jul	1500	5	0	95	1	0	0	0	0	0	0	1	1	Cerlan/Art-Leymus
28Jul	1520	5	0	90	1	0	0	0	0	0	2	5	7	Art/Ceraln-Stipa
28Jul	1535	15	1	80	2	0	0	0	0	0	2	10	15	Art/Cerlan-Stipa
28Jul	1545	2	0	95	2	0	0	0	0	0	1	5	6	Art/Cerlan-Stipa
29Jul	1630	0	15	15	5	80	2	0	3	5	0	0	0	Carex meadow
29Jul	1700	10		20	20	5	40	0	10	50	0	0	0	Alpine
1Aug	900	15	3	71	6	0	0	1	8	10	0	8	8	Art-Festuca/Poa
1Aug	1000	11	11	55	5	0	1	0	17	18	2	11	13	Art-Festuca/Poa
1Aug	1130	27	4	43	7	0	4	0	11	15	0	11	11	Art-Festuca/Poa
1Aug	1530	7	5	59	7	0	0	0	17	18	1	8	9	Art-Festuca/Poa
1Aug	1700	6	7	63	6	0	0	0	15	15	0	9	9	Art-Festuca/Poa
2Aug	1430	11	9	53	6	0	7	4	9	19	0	13	13	Art/Bromus/Stipa
2Aug	1600	16	20	49	16	0	6	0	3	10	0	9	9	Art/Bromus/
2Aug	1700	14	39	26	12	0	11	0	6	18	0	1	1	Art/Bromus/
4Aug	830	5	1	69	7	1	13	0	8	21	0	0	0	Astniv/Poa
4Aug	945	26	8	29	2	0	20	0	26	46	0	0	0	Astniv/Potentilla
5Aug	715	59	16	4	17	0	7	15	6	28	0	0	0	Astniv/Potentilla
MEAN		12	7	53	6	10	8	1	7	16	1	4	5	

*Community types are based on dominant cover. Art= Artemisia, Kralan=Krascheninnikovia ceratoides; Acan=Acantholimon; Astniv=Astragalus nivalis. Hord=Hordeum.

Standing crop for total grass, total forb, and total shrub averaged 130 kg/ha, 117 kg/ha and 47 kg/ha, respectively (Table 1). Mean total standing crop (sum of grass, grass-likes, forbs, and shrubs) was 300 kg/ha and varied from 30 kg/ha to 619 kg/ha showing high variability in site standing crop measurements and current site productivity. The 2008 information on standing crop will be added to information from previous years to establish community type productivity estimates and an estimate of grazing capacity for the Big and Little Pamir.

Degree of Use of a Sedge Meadow

Figures 3-5 are photos that show grazed and adjacent ungrazed sites (after the wire was removed). Vegetation was dominated by *Poa pratensis*, *Deschampsia caespitosa*, and *Carex* sp. The two "protected" sites had a mean total standing crop of 1220 kg/ha compared to 267 kg/ha for the adjacent grazed sites (Table 3). Mean litter was 540 kg/ha for the protected plots and 13 kg/ha for the grazed plots. Forbs (*Astragalus* sp. and *Potentilla* sp) were greater on the grazed plots, but for both grazed and ungrazed sites, grasses and sedges were dominant on all four clipped plots. If the difference between grazed and ungrazed plots was only associated with current livestock use, the use rate would be 78%. As these plots had been protected for some time, the difference between the plots is very likely associated not only with current protection from grazing use, but also from past use. In other words, the measure 78% utilization rate is likely an overestimate. However, this comparison does suggest very high forage use by livestock and a reduction of aboveground litter which would reduce carbon sequestration and soil productivity. Perhaps somewhat surprising to the range team is that there were few differences in

species found on the grazed and ungrazed sites which may be associated with having only 2 ungrazed plots and with the small area protected. This would certainly not make the ungrazed sites truly independent from its "pair." The species that was present on ungrazed and not grazed was *Deschampsia caespitosa*. This is a tufted species and is generally considered to have high palatability so it does appear that it was lost from the grazed areas on this site.

The results of the paired plot comparison must be considered as an estimate of use as stated above. These results, however, do also illustrate the productivity of these riparian communities. The standing crop mean of the ungrazed plots was 1220 kg/ha on 28 July 2008 and as another month of growth is expected these results suggest a seasonal above ground production of 2,000 kg/ha with a potential of 3,000 kg/ha or more. With overgrazing of sedge meadows, collecting of peat, ditching for draining or moving water, there is the substantial risk of changing hydrology and drying of these sites thereby greatly decreasing forage production and other values. This will be discussed in the following section on rangeland degradation.

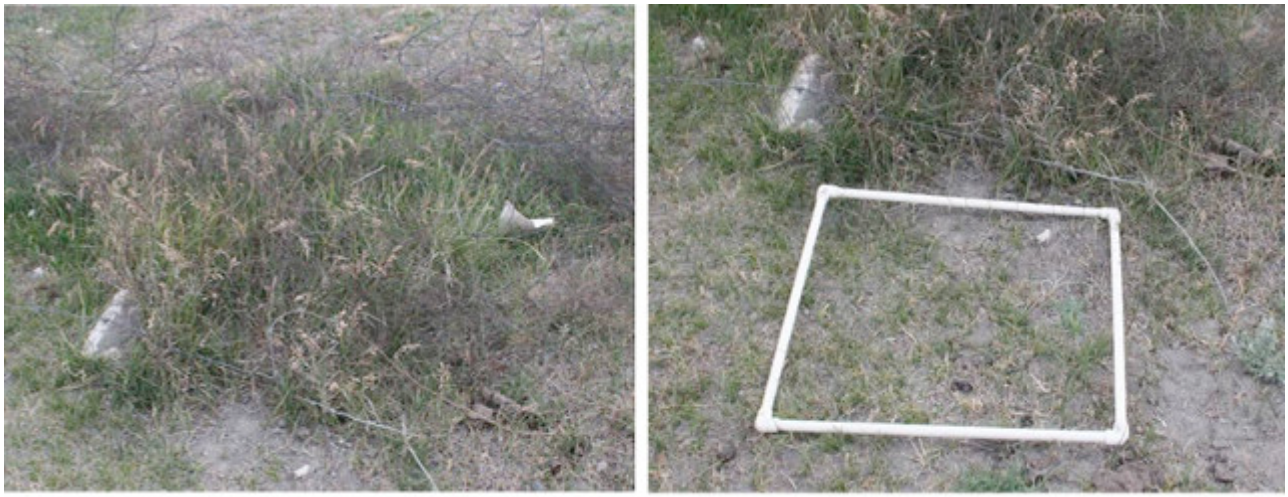

Figure 4. First paired plots showing grazed and ungrazed areas for measuring degree of grazing use (%).
Note: In top left photo (ungrazed) no plot is shown. Grazed area is shown in right photo and plot is located on clipped site.

Figure 5. Second paired plots showing grazed and ungrazed areas for measuring degree of grazing use (%).

Table 3. Comparison of grazed and ungrazed paired plots in a riparian area of Qirtshin Aq Djelgha.

	Ungrazed Plot 1	**Ungrazed Plot 2**	**Grazed Plot 1**	**Grazed Plot 2**
Plot Variable	***Standing Crop (kg/ha)***			
Grasses	928	340	190	58
Grass-likes	488	636	22	130

Forbs	0	48	68	66
Total Standing Crop	1416	1024	280	254
Litter	480	600	20	6
	Cover Estimate (%)			
Poa pratensis	55	20	25	5
Carex sp.	40	40	20	20
Deschampsia sp.	5	10	0	0
Litter	75	75	5	5
Forbs	0	5	5	5
Total Plant and Litter Cover	175	150	55	35
Bare ground	1	1	50	75

Rangeland Health. Rangeland health degradation was estimated as extreme or moderate to extreme on 62.5% of the sites, 30% of sites showed moderate degradation and the remaining 7.5% of sites were rated as having none or slight indicators of rangeland degradation (Table 4). Of the categories used to indicate changes in health (see table 4), the most important were bare ground, physical and chemical soil crusts, soil surface organic matter, plant composition/distribution relative to infiltration, plant functional/structural groups and annual production. Few sites showed "noxious" plant invasion and annuals are uncommon in the Wakhan. "Invading" plants were mostly *Astragalus nivalis*, *Potentilla* sp., and other low growing forbs. In most upland sites livestock grazing had reduced grass cover and grasses are often found only beneath shrubs or protected by rocks. Where this has occurred there are changes in plant functional groups (reduced perennial grasses and possibly increases in forbs) and decreased annual production. Very little litter (vegetation from past year's growth) was present on these rangelands except as dead plants. Obviously, in the dryer low elevation sites low soil organic matter and low amounts of litter are natural, but grazing has exacerbated the situation by removing almost all grasses. Evidence of soil loss from water erosion (gullies, rills, water flow patterns) is not unusual, but soil crusting, lack of litter, reduced vegetation cover and evidence of water erosion seem more critical in the Wakhan.

Rangeland Degradation

As stated in previous rangeland reports, there is little doubt that rangelands of the Wakhan area have degraded, a condition associated with overgrazing and other human impacts. These rangelands have been grazed for centuries if not millennia by livestock and longer by wildlife. Current concentrated livestock use around "villages," more preferred sites, and possibly long grazing periods (from almost "green-up" to fall) has resulted in widespread rangeland degradation; however, it is often very difficult to separate natural arid conditions from overgrazing on many sites. Other direct human impacts on rangelands include shrub harvesting for fuel, use of medicinal plants, hay cutting, use of peat from sedge meadows for fuel, ditching/irrigation practices, but certainly livestock grazing has much wider? distributed impacts across the landscape. In the following section, the processes of rangeland degradation are described for some important rangeland sites with the use of photos to illustrate changes. This section describes rangeland degradations associated with trailing and shrub collecting and describes degradation processes on two community types, sedge meadow and *Bromus stenostachyus*, which are two of the most productive community types. On all sites rangeland degradation is associated with

multiple factors (overuse of plants, trampling, shrub collecting, etc.). Data on changes in rangeland degradation are still being analyzed and will be described more fully in the final report and for work done during 2006-08 field seasons.

Table 4. Summary of rangeland health evaluation indicators determined in July/August 2008 for Wakhan Corridor using a rapid rangeland reconnaissance methodology (N=20).

	Descriptors/Rating Classes				
Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills	0	30	20	45	5
2. Water Flow Patterns	0	40	10	45	5
3. Pedestals or Terrecettes	0	45	35	20	0
4. Bare Ground	35	35	20	10	0
5. Gullies	0	25	15	55	5
6. Wind Scoured Areas	20	20	5	45	10
7. Litter Movement	30	15	45	5	5
8. Physical & Chemical Soil Crusts	40	15	15	30	0
9. Soil Surface Organic Matter	40	30	30	0	0
10. Plant Composition/ Distribution Relative to Infiltration/RO	40	30	15	15	0
11. Compaction Layer	40	20	10	25	5
12. Plant Functional/Structural Groups	40	20	15	25	0
13. Plant Mortality	35	15	25	25	0
14. Litter Amount	50	5	15	30	0
15. Annual Production	50	20	20	10	0
16. Noxious & Invasive Plants	5	15	30	50	0
17. Perennial Plant Reproductive Capability	30	15	15	40	0
Rangeland Health Degradation	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
Soil/Site Stability (Indicator 1-10)	45	20	25	10	0
Biotic Integrity (Indicator 11 -16	50	10	35	5	0

Livestock Trailing. Trailing by livestock is a significant resource concern in increasing bare-ground (Fig. 6) and increasing soil erosion and mass movement of soil. The trails obviously become compacted and "disturbance" species invade along the edges of trails. Over time larger areas are impacted. These trails are more obvious on steeper slopes, near camps or villages, and near main trails, but trailing is quite wide-spread, likely associated with relatively narrow stock movement areas

along the valleys throughout the Big and Little Pamir. Trailing also can result in gully formation that down-cuts through wetland sites resulting in drying conditions and severe degradation (see section on Sedge Community type degradation). The trailing on steeper slopes is generally a more significant resource problem as it causes greater soil movement (see sections on sedge community type and *Bromus stenostachys* community type degradation), but as much of the Wakhan area is dominated by steep slopes, there seems to be few potential solutions other than allowing for rest of areas impacted.

Figure 6. Two photos of livestock trailing damage. The steeper slope (left photo) is in the Big Pamir and the second photo (right photo) is in the Little Pamir.

Degradation Processes in the *Bromus Stenostachyus* Community Type. The *Bromus stenostachyus* community type is a productive grassland type with above ground biomass (predominately grasses) averaging 600 kg/ha. As stated previously, the *Bromus stenostachyus* type is a relatively uncommon community type and was never found occupying large areas, but it did occur through many of the mountain valleys of the Big and Little Pamir. It was found predominately on moderately steep slopes; however, it is speculated that this type may be an important "potential climax plant community" on major areas of the Big and Little Pamir valleys. On many sites one or a few *Bromus stenostachys* plants were all that was observed in deteriorated grasslands (Fig. 7 and 8). In figure 7 a relatively good condition *Bromus stenostachys* community is shown in the left photo and the right photo shows "remnant plant" on a highly degraded site (note that in background bare ground is very high and vegetation short).

Figure 7. Photos showing a *Bromus stenostachyus* community type (left photo) in good condition and a poor condition areas (right photo) with low plant cover and only few remnant plant *Bromus stenostachyus* plants.

The rangeland team had only three transects in the *Bromus stenostachyus* community type as most areas of this community type were small in area and/ or very isolated on steep rocky slopes. However, from examinations of several sites it is hypothesized that degradation results from trailing/trampling which causes mass soil movement, subsequent drying of the site, and with time the grazing removes most of *Bromus stenostachyus* as it is a tall species. This hypothesis is illustrated in Figure 8 using photos showing changes in plant and site conditions. The first photo (upper left) is a *Bromus stenostachyus* community with good cover and productivity. The second photo (bottom left), shows how trailing and trampling results in soil loss around the crown of the *Bromus stenostachyus* plants leaving roots and crowns to dry. The upper right photo shows a "remnant" *Bromus stenostachyus* plant with reduced vigor. The last photo (bottom right) shows greater degradation where the *Bromus stenostachyus* plants are much smaller and there is the subsequent increase in bareground and a loss of site productivity. The top left photo is from one site; whereas, the other three photos are from the same area with different levels of grazing use.

It was evident that *Bromus stenostachyus* is a relatively "coarse" grass that can become "wolfy,"[4] if(?) not grazed. Figure 9 is used to show an area where the plants appear "wolf" (left photo) and this photo also shows high organic matter associated within a clump of *Bromus stenostachyus* plants. The right photo in figure 9 shows a grazed group of plants, reduced organic matter, and surrounding soil conditions where there is little vegetation cover. The high productivity of this community type suggests it is one that needs further study to determine how these communities can be managed and increased. It is estimated the potential above ground production of these communities is 1000 kg/ha compared to less than 250 kg/ha on most of the sites where *Bromus stenostachyus* is found in the Wakhan area.

[4] A "wolf" plant is one that is normally palatable but because of old stems and leaves becomes less palatable to grazing animals.

Figure 8. A group of photos show the process of rangeland degradation in the *Bromus stenostachyus* cover type.

Figure 9. Photos illustrating the significant organic matter around the crowns of *Bromus stenostachyus* (note pencil in foreground). The second photo is one showing high grazing use of the plants and subsequent reduced vigor.

Degradation Process in the Sedge Meadow Community Type. The most productive rangeland type is the Sedge (*Carex sp.* and *Kobresia* spp) Meadow/Wetland Community Type[5]. These sites are located in subirrigated and wetland areas along springs, streams, and other sites with high water tables on relatively flat areas. The sedge meadow cover types are found throughout the upper elevations of the Wakhan Corridor. In general, sedge meadows are limited in area, but are widely

[5] The sedges (mainly *Carex* and *Kobresia*) are difficult taxonomic groups and no doubt there are several community types within this cover type.Several Sedge Meadow Community Types likely exist but are grouped for discussion.

distributed and no doubt supply significant amounts of forage for livestock and Marco Polo sheep.

Often these sites are "boggy" and have a high organic layer (peat) that is often collected and burned by pastoralists. A second sedge type exists on relatively steep mountain slopes at higher elevations where there is additional water from snow melt. These sites are often relatively narrow bands but supply a valuable and productive grazing resource. The predominant cover is over 90% sedges, but the sites do have significant diversity but low coverage of other species.

The sedge meadows are tolerant to grazing and will withstand heavy grazing pressure. However, it is apparent that with continued overgrazing site conditions change. Also, any factors that result in decreased water flow into these areas will be very detrimental to this community. In sedge meadows dominated by *Kobresia capillifolia* and other tall *Kobresia* or *Carex* species there is a change in species composition, initially to shorter *Kobresia* and/or *Carex* species. On some wetland sites *Juncus* species may also increase but *Juncus* did not appear to be common. *Carex melantha* is s shorter *Carex* species, but it is highly palatable (observed high use on this species by livestock throughout the sedge meadows), is rhizomatous, and would seem to have relatively high grazing tolerance. It appears to increase on moderately disturbed sites. As much of the Wakhan has been intensively grazed for a very long period it is difficult to hypothesize on the "climax" composition of these sites. At some of these meadows there were small amounts of *Deschampsia caespitosa* and *Phleum alpinum*, grass species with high palatability and considered "decreasers" (dominant species in climax communities and decrease with grazing) where found in the U.S.. It is speculated that the current composition of most sedge meadows has been influenced strongly by livestock grazing that has altered species composition. However, the most observable impact of livestock degradation (and other human related problems) on these sedge meadows is associated with factors that result in the drying of these communities.

In figure 10 several photos are used to illustrate different conditions of sedge meadows. The first photo (upper left) shows a sedge meadow dominated by tall *Kobresia* and *Carex* species in good condition with little degradation. The bottom left and upper right are two sites showing extreme degradation from gullying/mass soil movement and the drying and loss of productive rangeland conditions. The bottom left photo is of a hillside sedge meadow where trailing and grazing is hypothesized to have initiated mass soil movement degrading/destroying much of the sedge meadow on the hillside. The top right illustrates extreme productivity loss associated with the degradation of a sedge type where current cover is mostly bare ground, and it was hypothesized that the degradation of this site was associated with overgrazing that resulted in gully formation and loss of water to the site. The bottom right photo is of a large *Kobresia* "clump" showing grazing use, large amount of organic matter and surrounding drying of the site. Overgrazing reduces the ability of these taller, more productive species to remain on these sites and also begins the process of drying the site which is associated with greater bare ground, more compaction, and altering hydrological site conditions.

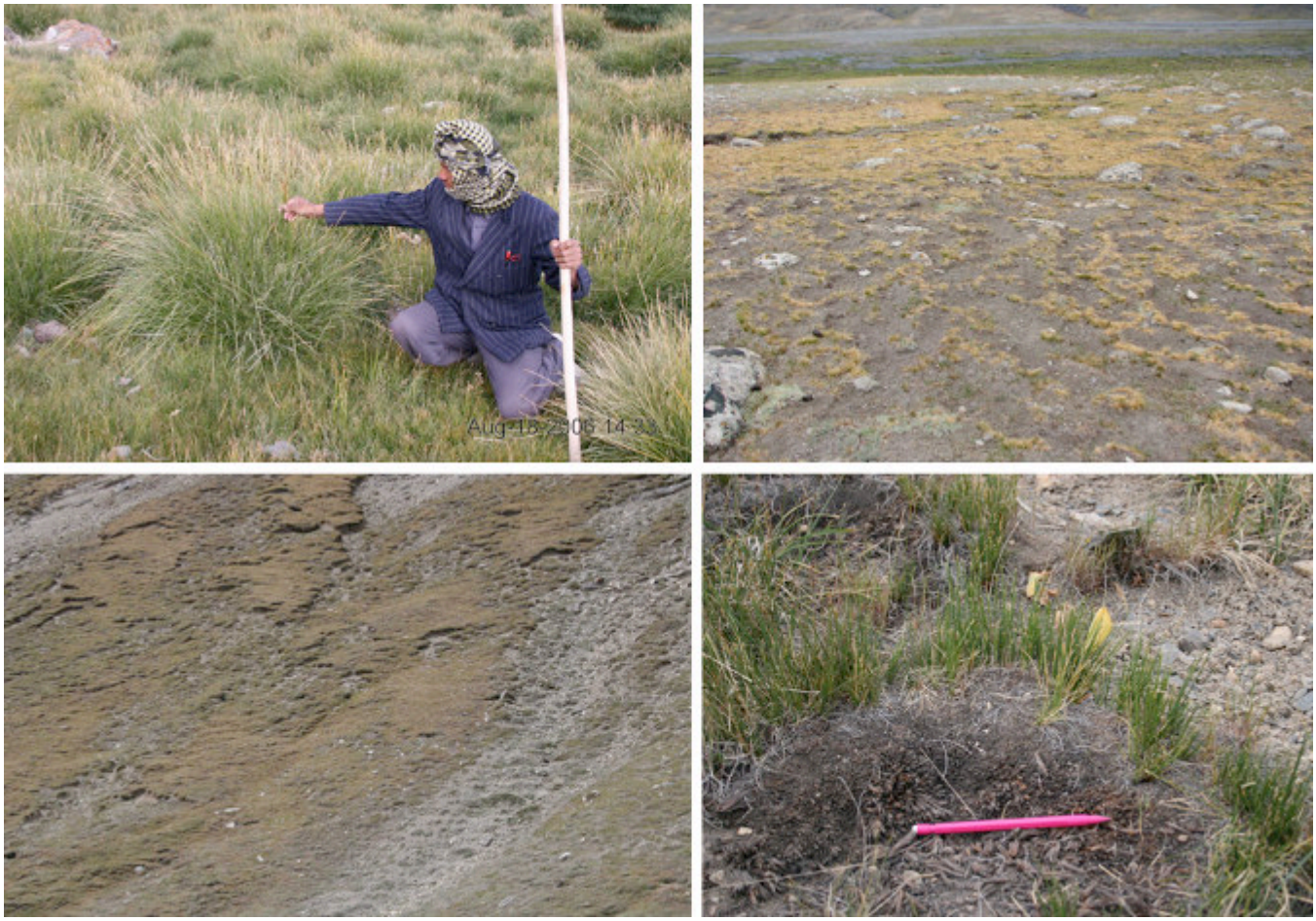

Figure 10. Photos illustrating a productive sedge meadow (upper right) and other sites showing degradation processes.

The drying of sedge meadows may occur from several processes that lower the water table and thus dry the upper soil layers. The drying of sedge meadows occurs when ditches are dug to allow for drier camp sites (see figure 11, left photo) or when constructed to irrigate other sites. Ditching (to drain wetlands) and irrigation "canals" are evident in many areas. Herders irrigate areas for growing hay (although most sites I observed where hay was harvested were in natural wet meadows). Many of the irrigation ditches appear quite old (perhaps from Soviet times) although newer ditches were also evident. Sites in which irrigation water is removed can result in a change in hydrology and drying of the site. It was also observed that the digging of "peat and sedge mats" often increases drying of sedge meadows by increasing soil loss and down-cutting. On some sites it was observed that these peat mats were used to secure the bottom edge of ger felt (and for fuel) and in figure 11 (right photo) large areas of "dug-out" sedge mat can be seen in the background as bare ground. In conjunction with these processes overgrazing decreases the ability of the sedge meadow to re-colonize the site and there is a subsequent drying of the area. This apparently occurred in several small sedge meadows observed in the Big and Little Pamir. At this time, digging ditches to move irrigation water or to drain sites is seen as causing only localized problems with rangeland degradation, but is a potential problem that should receive additional monitoring. Of greater concern is overgrazing on many sites widely distributed across the landscape.

Figure 11. Photos showing down-cutting associated with ditching (left photo) and site where sedge meadow mat removed (right photo).

As stated before, overgrazing and trailing can result in gully formation, down-cutting and drying of sedge meadows. The photos in figure 12 show two areas, the first (left photo) shows a "stringer" *Carex* meadow that is now "elevated" associated with down-cutting of drainage area. This was a relatively common phenomenon on many mountain valleys; and although these "stringer" *Carex* meadows are narrow, they are very productive when not degraded. The second photo in figure 12 (right photo) shows a gully that formed in an area that was hypothesized to have been a sedge meadow but now is very degraded. There is no way to determine how long or how the drying of this sedge meadow began, but it is clear that it is a relatively common phenomenon on many areas.

In figure 13, two soils pits are shown from nearby sites that were quite similar except for plant species present. The left photo is of an area dominated by sedges, but is overgrazed and beginning to show significant signs of degradation. The photo on the right is of an area dominated by *Astragalus/Potentialla* and was hypothesized to have been a sedge meadow and now in a very degraded condition. The soil pit area shown in the right photo has become drier, species are predominately low palatability forbs, and organic matter has decreased in soil surface layers (note high organic matter in left photo near soil surface). It is speculated that in some sites calcium carbonate increases as pH increases and *Hordeum* sp. (lower palatability and lower productivity grass species) may increase.

Figure 12. Photo showing drying of sedge meadow areas.

As the sedge meadows are the most productive rangeland communities, the degradation of these sites is a concern because of the loss in forage production and general site productivity. It is unknown how much of the area is significantly impacted by the drying of sedge meadows, but it is likely that the problem is very significant. The degrading conditions in valleys such as the upper D.e-Warm apparently occurred some time ago (possibly several decades or longer), but conditions in this valley are continuing to degrade. To improve and maintain these sites will take a concerted education effort. It is critical that these areas do not receive continual livestock grazing and if signs of gully formation occur the area needs to be rested from livestock grazing to allow recovery. As pasture areas of the Big and Little Pamir area are designated as spring, summer, or fall pastures, it would seem that these sites would generally have time to recover from grazing. However, in many valleys these sites seem to have continual growing season grazing. Some exceptions occur such as in the Little Pamir where hay is cut in some of these sedge meadows and in other areas where the sedge meadows are so wet the animals do not use as intensively.

Figure 13. Two soil pits showing similar soil depth and characteristics and different degradation conditions. These pits were in the same area and were postulated as the same site (same land form), but vegetation conditions were very different. With the left photo dominated by overgrazed *Carex* meadow and the right photo by *Astragalus/Potentilla* and believe to be a "dried" and degraded former sedge meadow site.

***Artemisia* Shrubland Degradation.** There are several *Artemisia* shrub species found in the Wakhan. These *Artemisa* shrubs species vary in size and generally in site found, but in all cases these shrubs, as well as other shrubs, are used as fuel by local peoples. It is believed that shrubs are used mainly for cooking and dried manure used mainly for heating. The impact of shrub collection on rangeland degradation is difficult to quantify (again there are no areas where shrubs are not collected), but the impacts can be observed across the landscape. The most visible impact is near camps, but there is almost continual collection as herders move away from their camps. Figure 14 is a group of photos used to illustrate how shrubs are collected and subsequent impacts on plant communities. In the upper left photo a winter camp is shown where shrubs have

been stored, but this same situation was observed in all seasonal camps as there is no other source of fuel. Two shrub collection sites are shown in the bottom left and top right photos where few shrubs exist and vegetation consists of mostly low forbs. These forbs were legumes (low spreading *Astragalus* and *Oxytropis* sp), *Potentilla* sp., *Neptea* (*N. pamirica* and N. *podostachys*), and *Dracocephalum Paulsenii* with low grazing value associated with high anti-herbivory compounds. The bottom right photo shows a remaining shrub "protecting" a grass plant ("protection is not 100% as part of the grass has been grazed earlier in the season) that is relatively vigorous (flower heads prevalent and long leaves). On these sites, grass production was very low and overgrazing of the sites was extreme. One could speculate that *Artemisia* shrubs would compete with grass and other forage species for soil water and nutrients, but it is more likely that the benefits of the shrubs in protecting the site (increasing vegetation cover and insulating the soil surface from high and low temperatures, reducing wind across soil surface, holding snow, etc.) is much greater than any deleterious effects. As such, the conservative use of fuel shrubs is important to insure that there are mature shrubs to reseed harvested sites and to protect the site from wind and water erosion. Shrubs will reduce wind speed across the soil, hold snow and blowing soil, reduce soil temperature fluctuations compared to bare soil,, and increase site productivity as well as provide some cover and browse for wild species. Shrubs facilitate grasses (protect some grasses from continual livestock grazing), allowing for a seed source for the grasses to reproduce and revegetate disturbed sites, and often shrubs modify soil conditions improving growth of grasses and forbs within the shrub canopy zone. Removal of all shrubs in the Wakhan environment will lead to decreased grass vigor and production and very degraded sites. The rangeland team did not collect information on preferred species for fuel and level of harvest. General observations suggest that the taller *Artemisia* species were most often collected, but at times significant *Krascheninnikovia lanata*, a palatable browse species, was seen in villages. It is clear that additional information is needed on issues related to shrub harvest and its impacts on rangelands to allow for the development of shrub conservation planning in local villages. For example, information is needed on average fuel use by households by season, type of shrubs preferred, potential for improved fuel use efficiency with adoption of improved stoves, methods of reestablishing shrubs on depleted sites and procedures to reduce negative impacts of shrub harvest on different sites.

Figure 14. Photos illustrating shrub harvest and degradation of *Artemisia* steppe.

Summary and Concluding Statements

During 2008 we established 28 plots for the collection of plant community and soil samples for measurement of pH and ECe. Plant community data collected in 2006, 2007 and 2008 will be the basis of ecological site information that will aid in determining the values of different ecological sites and plant communities for livestock and wildlife and for determining rangeland degradation attributes. A comprehensive plant list has also been updated and is included as Appendix 3. This list includes 54 plant families and 530 species.

Rangeland degradation in the Wakhan was hypothesized as moderate to high in the 2007 report. In 2008, most areas evaluated were estimated as having moderate to high degradation. Rangeland degradation of two of the most productive types, the sedge meadow and *Bromus stenoostachyus* community types, are described. Degradation associated with trailing and shrub harvest are also discussed. A major difficulty in defining the level and/or types of rangeland degradation is that few sites exist where grazing is not significant. There are also no plant guides or site information for these rangeland types. Additional information on rangeland degradation is currently being analyzed and will be included in the final report.

A rangeland geographic information system (GIS) with all transects data, photo-points, and reconnaissance information has been developed. The GIS system will allow other researchers to revisit transect sites and have access to all rangeland data to determine change with time. The rangelands of the Wakhan Corridor are quite variable spatially and the low productivity, high topographic variation, and high natural and human (livestock) disturbance make classifications using

the available imagery (Landsat ETM and TM images) difficult. However, because of the large area and difficulty of accessing the area (only by foot or animal) the final rangeland classification will be based on remote sensed data for rangeland analyses.

Literature Cited

Mock, John and Kimberley O'Neil. 2005. Wakhan and the Afghan Pamir (text). www.mockandoneil.com.

Appendices

Appendix 1. Location of pictographs (latitude and longitude) date and time for identifying associated photos, and elevation and photos of pictographs.

Data are also part of Rangeland GIS in the Field Notes 2008 shape file. As these pictographs are predominately along major trails, it is believed they have been included in past data collected by WCS teams.

Latitude	Longitude	Date/Time	Elevation (m)	Location or Description
37.0184434	73.5986871	20-JUL-08 10:052:28	4243	Trail
37.1464108	73.6291201	21-JUL-08 12:32:58	4243	Near river.
37.1200324	73.8209043	23-JUL-08 14:50:44	4459	Pictograph
37.1899000	73.6766400	31-JUL-08 9:25:00	4368	Faded pictograph.
37.1333974	73.5721045	02-AUG-08 16:10:00	4368	Large rock outcrop.
37.0104247	73.4397974	05-AUG-08 10:07:50	3370	Pictographs near Sarhad e Broghil

2008-07-20-10-02-34-000.jpg

2008-07-21-12-33-26-000.jpg

2008-07-23-14-54-38-000.jpg

2008-07-31-09-27-41-000.jpg

2008-08-02-18-16-19-000.jpg

2008-08-05-10-07-42-000.jpg

2008-08-05-10-07-41-000.jpg

Appendix 2. Plot photos for transect to illustrate a site that could be used for a permanent monitoring plot.

August 5, 2008_0715. Bromus/Cicer grassland (37.0541400N; 73.4580900E) at 4078 m. Aspect and slope were 80 and 34 degrees, respectively. First 3 photos are from start to end point (east to west) on transect with a 278 degree transect direction. Photos of plots are of 10 m, 20m, 35m (moved from 30 m as 30 m was on a marmot dig), and 40 m plots clipped for biomass. Two photos are from end point to start point of transect. Other photos of soil pit and miscellaneous site photos.


Aug-05-2008 07:18


Aug-05-2008 07:22


Aug-05-2008 07:30


Aug-05-2008 07:37


Aug-05-2008 07:45


Aug-05-2008 07:57


Aug-05-2008 07:58


Aug-05-2008 08:01


Aug-05-2008 08:01


Aug-05-2008 08:01


Aug-05-2008 08:06

Table . List of plants by family for Wakhan Corridor study area.

APIACEAE
Aulacospermum stylosum
Bupleurum exaltatum
Bupleurum gracillimum
Carum carvi
Cortia papyracea
Ferula Narthex
Ferula Grigorijevii
Ligusticum afghanicum
Ligusticum marginatum
Ligusticum Thomsonii
Semonovia radiata
Semonovia pamirica
Semonovia lasiocarpa
Tetrataenium Olga
Pleurospermum Hookeri
Hymenolaena badachshanica

ASTERACEAE
Acroptilon repens
Anaphalis virgata
Anaphalis darvasica
Artemisia albida
Artemisia biennis
Artemisia dracunculus
Artemisia leucotricha
Artemisia Lehmanniana
Artemisia macrocephala
Artemisia perisica
Artemisia Roxburghiana
Artemisia rupestris
Artemisia rutaefolia
Artemisia santolinifolia
Artemisia scoparia
Artemisia siversiana
Artemisia stricta
Artemisia tecti-mundi
Artemisia vachanica
Aster flaccidus
Centaurea pulchella
Chondrilla phaecophala
Chonrilla maracandica
Chichorium intybus
Cirsium argyracanthum
Cirsium arvense
Cirsium rhizocephalum
Cousinia auriculata
Cousinia bupthalmoides
Cousinia chionophila
Cousinia khashensis
Cousinia thompsonii
Cousinia schugnanica
Cousinia takharensis
Crepis corniculata

Crepis flexuosa
Crepis multicaulis
Crepis pulchra
Echinops chloroleucus
Echinops nanus
Echinops wakhanicus
Eremus stenophyllus
Erigeron petroiketes
Erigeron pseudericephalus
Hieracium virosum
Inula Rubtzovii
Inula salsoloides
Gypsophila herneriarioides
Lactuca tatarica
Lactuca orientalis
Lactuca scariola
Ligularia alpigena
Leontopodium ochroleucum
Mulgedium tataricum
Picris nuristanica
Psychrogeton amorphoglossus
Psychrogeton andryaloides
Psychrogeton cabulicus
Psychrogeton olgae
Saussurea Gilesii
Saussurea Jacea
Saussurea glacialis
Saussurea gnaphaloides
Saussurea salsa
Scariola orientalis
Scorzonera virgata
Senecio Korshinskyi
Senecio Krascheninnikovii
Senecio Paulsenii
Spathipappus griffithii
Tanacetum djilgense
Tanacetum pyrethroides
Tanacetum tibeticum
Tanacetum Senecionis
Tanacetum pamiricum
Scariola orientalis gracilis
Scorzonera virgata
Sonchus oleraceus
Taraxacum bessarabicum
Taraxacum badachschanicus
Taraxacum bicolor
Taraxacum behzudicum
Taraxacum breirostre
Taraxacum chitralense
Taraxacum crepidiforme
Taraxacum karakoricum
Taraxacum leucanthum
Taraxacum pseudo-leucanthum
Tragopogon gracilis
Waldhemia nivea
Waldheimia Stoliczkae

Waldhemia tomentosa
Waldheimia tridactylites

BETULACEAE
Betula chitralica

BORAGINACEAE
Anchusa ovata
Arnebia euchroma
Arnebia guttata
Asperugo procumbens
Cynoglossum glochidiatum
Lappula microcarpa
Lindelofia macrostyla
Lindelofia stylosa
Mattiastrum acrocladum
Myostois asiatica
Tianschaniella wakhanica

BRASSICACEAE
Arabidopsis Wallichii
Braya oxycarpa
Christolea crassifolia
Chorispora macropoda
Conringia planisiliqua
Descurainia sophia
Draba altaica
Draba korshinskyi
Draba oreades
Draba stenocarpa
Draba tibetica
Eruca sativa
Ermania himalayensis
Erysimum sisymbrioides
Goldbachia laevigata
Hymenolobus procumbens
Lepidium latifolium
Malcolmia strigosa
Matthiola tenera
Matthiola chorassanica
Neuroloma kunawarense
Phaeonychium surculosum
Sisymbrium brassiciforme
Smelowskia sp.
Tetracme pamirica
Tetracme quadricornis
Thalaspi cochlearioides

CAPPARIDACEAE
Capparis spinosa

CAPRIFOLIACEAE
Lonicera asperifolia
Lonicera semenovii
Lonicera obovata
Lonicera spinosa
Lonicera microphylla
Lonicera Semenovii
Lonicera stenantha
Lonicera Korolkovii
Lonicera nummulariifolia

CAROPHYLLACEAE
Acanthophyllum schugnanicum
Arenaria griffithii
Arenaria Koelzii
Arenaria serphllifolia
Cerastium beeringianum
Cerastium cerastioides
Cerastium pusillum
Cerastium tianschicum
Gypsophila cephalotes
Holosteum Kobresietorum
Lepyrodiclis holosteoides
Minuartia nuristanica
Silene conoidea
Silence gonosperma
Silene microphylla
Silene Moorcroftiana
Silene takhtensis
Silene winkleri
Stellaria Fontana
Stellaria Koelzii
Stellaria sarcophylla
Vaccaria oxyodonta
Vaccaria pyramidata

CHENOPODIACEAE
Atriplex pamiria
Bassia eriophora
Chenopodium album
Chenopodium botrys
Chenopodium foliosum
Chenopodium litwinowii
Chenopodium rubrum
Kochia prostrata
Krascheninnikowia ceratoides
Salsola collina
Salsola kali
Salsola Jacquemontii
Suada Olufsenii

CONVULACEAE
Convolvulus arvensis

CRASSULACEAE
Pseudosedum condensatum

Rosularia alpestris
Sedum Ewersii
Sedum heterodontum
Sedum pamiroalaicum
Sedum recticaule

CUPRESSACEAE
Juniperus semiglobosa

CUSCUTACEAE
Cuscuta europaea

CYPERACEAE
Carex atrofusca
Carex gilesii
Carex haematostoma
Carex Karoi
Carex melanantha
Carex migroglochin
Carex nivalis
Carex orbicularis
Carex parva
Carex pseudofoetida
Carex pamirica
Carex physodes
Carex songorica
Carex stenophylla
Carex stenocarpa
Elocharis palustris
Elocharis uniglumis
Elocharis quinqueflora
Koebresia capillifolia
Koebresia pamiroalaica
Koebresia schoenoides
Kobresia stenocarpa
Schoenoplectus tabernaemontani
Trichophorum pumilum
Schoenoplectus lacustris

ELAEAGNACEAE
Hippophae rhamnoides

EPHEDRACEAE
Ephedra fedtschenkoi
Ephedra regeliana
Ephedra intermedia

EUPHORBIACEAE
Euphorbia Aucheri
Euphorbia sp.

FABACEAE
Astragalus adpressipilosus
Astragalus bahrakianus
Astragalus charguschanus
Astragalus dignus

Astragalus Falconeri
Astragalus Hoffmeisteri
Astragalus leiosemius
Astragalus longistipitatus
Astragalus melanostachys
Astragalus orbiculatus
Astragalus Oxyglotis
Astragalus pindreensis
Astragalus rhizanthus
Astragalus rhizocephalus
Astragalus Toppinianus
Astragalus schacdarius
Astragalus Scheremetevianus
Astragalus tecti-mundi
Astragalus webbianus
Hedysarum wakhanicum
Hedysarum minjanense
Cicer acanthophyllum
Cicer macracanthum
Cicer Fedtschenkoi
Cicer microphyllum
Glycyrrhiza uralensis
Lathyrus sativus
Medicago sativa
Medicago lupini
Melilotus officinalis
Onobrychis Echidna
Oxytropis asterocarpa
Oxytropis bella
Oxytropis boguschi
Oxytropis chiliophylla
Oxytropis chitralensis
Oxytropis crassiuscula
Oxytropis Gorbunovii
Oxytropis hirsutiuscula
Oxytropis immersa
Oxytropis kazidanica
Oxytropis lapponica
Oxytropis microsphaera
Oxytropis orephila
Oxytropis pagobia
Oxytropis Poincinsii
Oxytropis riparia
Oxytropis savellanica
Oxytropis tianschanica
Oxytropis trichosphaera
Pisum sativum
Trifolium repens
Trifolium physodes
Trigonella pamirica
Vicia angustifolfia
Vicia sativa

FUMARIACEAE
Corydalis fedtashenkoana

GENTIANANCEAE
Gentiana prostrata
Gentiana longicarpa
Gentiana stricta
Gentiana olivieri
Gentiana kaufmanniana
Genitana longicarpa
Gentiana marginata
Gentiana minutissima
Gentiana riparia
Gentiana aquatica
Lomatogonium carinthiacum
Swertia lactea (most)
Swertia petiolata

GERANIACEAE
Geranium collinium
Geranium himalayense
Geransium regelii

GROSSULARIACEAE
Ribes villosum

HIPPURIDACEAE
Hippuris vulgaris

JUNCACEAE
Juncus articulatus
Luzula spicata

JUNCAGINACEAE
Triglochin maritimum
Triglochin palustre

LAMINACEAE
Dracocephalum heterophyllum
Dracocephalum Paulsenii
Dracocephalum stamineum
Eremostachys sp.
Elsholtzia densa
Hymenocrater sessilifolius
Lagochilis cabulicus
Lagochilis schugnanicus
Lamium amplexicaule
Mentha longifolia
Neptea daensis
Neptea discolor
Nepeta fedtschenkoi
Nepeta floccosa
Nepeta pamirensis
Neptea Paulsenii
Nepeta podostachys
Neptea spathulifera
Neptea subincisa

Phlomis canescens
Prunella vulgaris
Scutellaria Heydei
Thymus linearis
Ziziphora clinopodioides

LENTIBULARIACEAE
Utricularia vulgaris

LILIACEAE
Allium Fedtschenkoanum
Allium carolinianum
Allium filifolium
Allium hymenorrhizum
Allium pamiricum
Allium schoenoprasoides
Asparagus persicus
Eremurus stenophyllus
Gagea chloroneura
Gagea exilis
Gagea Jaeschkei
Gagea siphonantha
Gagea stipitata
Lloydia serotina

LINACEAE
Linum mesotylum

MALVACEAE
Malva rotundifolia
Malva pamiroalaica

ONAGRACEAE
Epilobium angustifolium
Epilobium latifolium
Epilobium tibetanum

ORCHIDACEAE
Dactylorrhiza kafiriana

OROBANCHACEAE
Orobanche cernua

PAPAVERACEAE
Papaver nudicaule

PARNASSIACEAE
Parnassia palustris

PLANTAGINACEAE
Plantago gentianoides
Plantago depressa

PLUMBAGINACEAE
Acantholimon auganum
Acantholimon diapensioides

Acantholimon erythraeum
Acantholimon Gillii
Acantholimon lycidesopodio
Acantholimon pamiricum
Acantholimon pulchellum
Acantholimon Zaprjagaevii

POACEAE
Agropyron alaicum
Agropyron canaliculatum
Agropyron cognatum
Agropyron repens
Agrostis stolonifera
Agostis tenuis
Alopecurus himalaicus
Avena fatua
Avena sativa
Bromus gracillimus
Bromus japonicus
Bromus lanceolatus
Bromus tectorum
Bromus tomentosus
Bromus stenostachyus
Calamagrostis dubia
Calamagrosits pseudophragmites
Colopodium afghanicum
Deschampsia caespitosa
Deschampsia koeleriodes
Elymus dahuricus
Elymus dasystachys
Elymus nutans
Eremopoa perisica
Festuca alaica
Festuca altaica
Festuca arundinacea
Festuca rubra
Hordeum brevisubulatum
Hordeum turkestanicum
Koeleria cristata
Lolium rigidum
Malacurus lanatus
Melica jacquemontii
Panicum miliaceum
Phleum alpinum
Phragmites australis
Puccinellia sevangensiss
Puccinella distans
Oryzopsis latifolia
Oryzopsis lateralis
Oryzopsis gracilis
Oryzopsis pubiflora
Oryzopsis purpurascens
Poa afghanica
Poa alpigina
Poa alpina
Poa Litwinowiana

Poa pratensis
Poa Roemeri
Polypogon monspeliensis
Secale cereale
Setaria viridis
Stipa barbata
Stipa caucasica
Stipa glareosa
Stipa mongholica
Stipa pennata
Stipa trichoides
Stipa splendens
Triticum aestivum

POLYGONACEAE
Atraphaxis spinosa
Oxyria digna
Polygonum arenastrum
Polygonum aviculare
Polygonum bucharicum
Polygonum convolvulus
Polygonum molliaeforme
Polygonummyrtillifolium
Polygonum sibiricum
Polygonum thymifolium
Polygonum paronychioides
Polygonum pyrifolia
Rheum tibeticum
Rheum spiciforme
Rumex Patientia
Rumex Paulsenianus

POTAMOGETONACEAE
Potamogeton amblyphyllus

PRIMULACEAE
Glaux maritma
Primula macrophylla
Primula pamirica
Primula Warshenewskiana

RANUNCULACEAE
Anemone biflora
Clematis Hilariae
Clematis orientalis
Delphinium afghanicum
Delphinium brunonianum
Halerpestes salsuginosa
Isopyrum anemonoides
Paraquilegia anemonoides
Pulsatilla campanella
Ranunculus alpigenus
Ranunculus longicaulis
Ranunculus natans
Ranunculus pamiri
Ranunculus pseudohirculus

Ranunculus rubrocalyx
Ranunculus rufosepalus
Ranunculus Shaftoanus
Ranunculus Trautvetterianus
Thalictrum alpinum

RUBIACEAE
Rubia tibetica
Rubia gedrosica
Rubia chitralensis
Galium tricornutum
Galium Vassilczenkoi

RHAMANACEAE
Rhamnus prostrata

ROSACEAE
Potentilla anserina
Potentilla argentea
Potentilla bifurca
Potentilla dealbata
Potentilla gelida
Potentilla multifida
Potentilla phyllocalyx
Potentilla sericea
Potentilla supine
Rosa Webbiana

RUBIACEAE
Galium ibicinum
Galium tricornutum
Rubia citralensis

SALICACEAE
Populus pamirica
Salix caesia
Salix excelsa
Salix iliensis
Salix pycnostachya
Salix schugnanica
Salix turanica

SANTALACEAE
Thesium himalense

SAXIFRAGACEAE
Saxifraga komarovii
Saxifraga hirculus
Saxifraga sibirica

SCROPHULARIACEAE
Euphrasia paghmanensis
Euphrasia secundiflora
Linaria bamianica
Pedicularis brevirostris
Pedicularis cheilanthifolia

Pedicularis dolichorrhiza
Pedicularis pulchra
Pedicularis rhinanthoides
Pedicularis uliginosa
Pedicularis verae
Scrophularia dentata
Scrophularia scoparia
Verbascum erianthum
Veronica Anagallis
Veronica biloba
Veronica michauxii

SOLANACEAE
Lycium ruthenicum

TAMARICACEAE
Myricaria elegans
Myricaria germanica
Myricaria squamosa

VALERIANACEAE
Valeriana Fedtschenkoi

ZYGOPHYLLACEAE
Peganum harmala

APIACEAE
Aulacospermum stylosum
Bupleurum exaltatum
Bupleurum gracillimum
Carum carvi
Cortia papyracea
Ferula Narthex
Ferula Grigorijevii
Ligusticum afghanicum
Ligusticum marginatum
Ligusticum Thomsonii
Semonovia radiata
Semonovia pamirica
Semonovia lasiocarpa
Tetrataenium Olga
Pleurospermum Hookeri
Hymenolaena badachshanica

ASTERACEAE
Acroptilon repens
Anaphalis virgata
Anaphalis darvasica
Artemisia albida
Artemisia biennis
Artemisia dracunculus
Artemisia leucotricha
Artemisia Lehmanniana
Artemisia macrocephala
Artemisia perisica
Artemisia Roxburghiana
Artemisia rupestris
Artemisia rutaefolia
Artemisia santolinifolia
Artemisia scoparia
Artemisia siversiana
Artemisia stricta
Artemisia tecti-mundi
Artemisia vachanica
Aster flaccidus
Centaurea pulchella
Chondrilla phaecophala
Chonrilla maracandica
Chichorium intybus
Cirsium argyracanthum
Cirsium arvense
Cirsium rhizocephalum
Cousinia auriculata
Cousinia bupthalmoides
Cousinia chionophila
Cousinia khashensis
Cousinia thompsonii
Cousinia schugnanica
Cousinia takharensis
Crepis corniculata
Crepis flexuosa
Crepis multicaulis

Crepis pulchra
Echinops chloroleucus
Echinops nanus
Echinops wakhanicus
Eremus stenophyllus
Erigeron petroiketes
Erigeron pseudericephalus
Hieracium virosum
Inula Rubtzovii
Inula salsoloides
Gypsophila herneriarioides
Lactuca tatarica
Lactuca orientalis
Lactuca scariola
Ligularia alpigena
Leontopodium ochroleucum
Mulgedium tataricum
Picris nuristanica
Psychrogeton amorphoglossus
Psychrogeton andryaloides
Psychrogeton cabulicus
Psychrogeton olgae
Saussurea Gilesii
Saussurea Jacea
Saussurea glacialis
Saussurea gnaphaloides
Saussurea salsa
Scariola orientalis
Scorzonera virgata
Senecio Korshinskyi
Senecio Krascheninnikovii
Senecio Paulsenii
Spathipappus griffithii
Tanacetum djilgense
Tanacetum pyrethroides
Tanacetum tibeticum
Tanacetum Senecionis
Tanacetum pamiricum
Scariola orientalis gracilis
Scorzonera virgata
Sonchus oleraceus
Taraxacum bessarabicum
Taraxacum badachschanicus
Taraxacum bicolor
Taraxacum behzudicum
Taraxacum breirostre
Taraxacum chitralense
Taraxacum crepidiforme
Taraxacum karakoricum
Taraxacum leucanthum
Taraxacum pseudo-leucanthum
Tragopogon gracilis
Waldhemia nivea
Waldheimia Stoliczkae
Waldhemia tomentosa
Waldheimia tridactylites

BETULACEAE
Betula chitralica

BORAGINACEAE
Anchusa ovata
Arnebia euchroma
Arnebia guttata
Asperugo procumbens
Cynoglossum glochidiatum
Lappula microcarpa
Lindelofia macrostyla
Lindelofia stylosa
Mattiastrum acrocladum
Myostois asiatica
Tianschaniella wakhanica

BRASSICACEAE
Arabidopsis Wallichii
Braya oxycarpa
Christolea crassifolia
Chorispora macropoda
Conringia planisiliqua
Descurainia sophia
Draba altaica
Draba korshinskyi
Draba oreades
Draba stenocarpa
Draba tibetica
Eruca sativa
Ermania himalayensis
Erysimum sisymbrioides
Goldbachia laevigata
Hymenolobus procumbens
Lepidium latifolium
Malcolmia strigosa
Matthiola tenera
Matthiola chorassanica
Neuroloma kunawarense
Phaeonychium surculosum
Sisymbrium brassiciforme
Smelowskia sp.
Tetracme pamirica
Tetracme quadricornis
Thalaspi cochlearioides

CAPPARIDACEAE
Capparis spinosa

CAPRIFOLIACEAE
Lonicera asperifolia
Lonicera semenovii
Lonicera obovata
Lonicera spinosa
Lonicera microphylla
Lonicera Semenovii
Lonicera stenantha
Lonicera Korolkovii
Lonicera nummulariifolia

CAROPHYLLACEAE
Acanthophyllum schugnanicum
Arenaria griffithii
Arenaria Koelzii
Arenaria serphllifolia
Cerastium beeringianum
Cerastium cerastioides
Cerastium pusillum
Cerastium tianschicum
Gypsophila cephalotes
Holosteum Kobresietorum
Lepyrodiclis holosteoides
Minuartia nuristanica
Silene conoidea
Silence gonosperma
Silene microphylla
Silene Moorcroftiana
Silene takhtensis
Silene winkleri
Stellaria Fontana
Stellaria Koelzii
Stellaria sarcophylla
Vaccaria oxyodonta
Vaccaria pyramidata

CHENOPODIACEAE
Atriplex pamiria
Bassia eriophora
Chenopodium album
Chenopodium botrys
Chenopodium foliosum
Chenopodium litwinowii
Chenopodium rubrum
Kochia prostrata
Krascheninnikowia ceratoides
Salsola collina
Salsola kali
Salsola Jacquemontii
Suada Olufsenii

CONVULACEAE
Convolvulus arvensis

CRASSULACEAE
Pseudosedum condensatum

Rosularia alpestris
Sedum Ewersii
Sedum heterodontum
Sedum pamiroalaicum
Sedum recticaule

CUPRESSACEAE
Juniperus semiglobosa

CUSCUTACEAE
Cuscuta europaea

CYPERACEAE
Carex atrofusca
Carex gilesii
Carex haematostoma
Carex Karoi
Carex melanantha
Carex migroglochin
Carex nivalis
Carex orbicularis
Carex parva
Carex pseudofoetida
Carex pamirica
Carex physodes
Carex songorica
Carex stenophylla
Carex stenocarpa
Elocharis palustris
Elocharis uniglumis
Elocharis quinqueflora
Koebresia capillifolia
Koebresia pamiroalaica
Koebresia schoenoides
Kobresia stenocarpa
Schoenoplectus tabernaemontani
Trichophorum pumilum
Schoenoplectus lacustris

ELAEAGNACEAE
Hippophae rhamnoides

EPHEDRACEAE
Ephedra fedtschenkoi
Ephedra regeliana
Ephedra intermedia

EUPHORBIACEAE
Euphorbia Aucheri
Euphorbia sp.

FABACEAE
Astragalus adpressipilosus
Astragalus bahrakianus
Astragalus charguschanus
Astragalus dignus

Astragalus Falconeri
Astragalus Hoffmeisteri
Astragalus leiosemius
Astragalus longistipitatus
Astragalus melanostachys
Astragalus orbiculatus
Astragalus Oxyglotis
Astragalus pindreensis
Astragalus rhizanthus
Astragalus rhizocephalus
Astragalus Toppinianus
Astragalus schacdarius
Astragalus Scheremetevianus
Astragalus tecti-mundi
Astragalus webbianus
Hedysarum wakhanicum
Hedysarum minjanense
Cicer acanthophyllum
Cicer macracanthum
Cicer Fedtschenkoi
Cicer microphyllum
Glycyrrhiza uralensis
Lathyrus sativus
Medicago sativa
Medicago lupini
Melilotus officinalis
Onobrychis Echidna
Oxytropis asterocarpa
Oxytropis bella
Oxytropis boguschi
Oxytropis chiliophylla
Oxytropis chitralensis
Oxytropis crassiuscula
Oxytropis Gorbunovii
Oxytropis hirsutiuscula
Oxytropis immersa
Oxytropis kazidanica
Oxytropis lapponica
Oxytropis microsphaera
Oxytropis orephila
Oxytropis pagobia
Oxytropis Poincinsii
Oxytropis riparia
Oxytropis savellanica
Oxytropis tianschanica
Oxytropis trichosphaera
Pisum sativum
Trifolium repens
Trifolium physodes
Trigonella pamirica
Vicia angustifolfia
Vicia sativa

FUMARIACEAE
Corydalis fedtashenkoana

GENTIANANCEAE
Gentiana prostrata
Gentiana longicarpa
Gentiana stricta
Gentiana olivieri
Gentiana kaufmanniana
Genitana longicarpa
Gentiana marginata
Gentiana minutissima
Gentiana riparia
Gentiana aquatica
Lomatogonium carinthiacum
Swertia lactea (most)
Swertia petiolata

GERANIACEAE
Geranium collinium
Geranium himalayense
Geransium regelii

GROSSULARIACEAE
Ribes villosum

HIPPURIDACEAE
Hippuris vulgaris

JUNCACEAE
Juncus articulatus
Luzula spicata

JUNCAGINACEAE
Triglochin maritimum
Triglochin palustre

LAMINACEAE
Dracocephalum heterophyllum
Dracocephalum Paulsenii
Dracocephalum stamineum
Eremostachys sp.
Elsholtzia densa
Hymenocrater sessilifolius
Lagochilis cabulicus
Lagochilis schugnanicus
Lamium amplexicaule
Mentha longifolia
Neptea daensis
Neptea discolor
Nepeta fedtschenkoi
Nepeta floccosa
Nepeta pamirensis
Neptea Paulsenii
Nepeta podostachys
Neptea spathulifera
Neptea subincisa

Phlomis canescens
Prunella vulgaris
Scutellaria Heydei
Thymus linearis
Ziziphora clinopodioides

LENTIBULARIACEAE
Utricularia vulgaris

LILIACEAE
Allium Fedtschenkoanum
Allium carolinianum
Allium filifolium
Allium hymenorrhizum
Allium pamiricum
Allium schoenoprasoides
Asparagus persicus
Eremurus stenophyllus
Gagea chloroneura
Gagea exilis
Gagea Jaeschkei
Gagea siphonantha
Gagea stipitata
Lloydia serotina

LINACEAE
Linum mesotylum

MALVACEAE
Malva rotundifolia
Malva pamiroalaica

ONAGRACEAE
Epilobium angustifolium
Epilobium latifolium
Epilobium tibetanum

ORCHIDACEAE
Dactylorrhiza kafiriana

OROBANCHACEAE
Orobanche cernua

PAPAVERACEAE
Papaver nudicaule

PARNASSIACEAE
Parnassia palustris

PLANTAGINACEAE
Plantago gentianoides
Plantago depressa

PLUMBAGINACEAE
Acantholimon auganum
Acantholimon diapensioides

Acantholimon erythraeum
Acantholimon Gillii
Acantholimon lycidesopodio
Acantholimon pamiricum
Acantholimon pulchellum
Acantholimon Zaprjagaevii

POACEAE
Agropyron alaicum
Agropyron canaliculatum
Agropyron cognatum
Agropyron repens
Agrostis stolonifera
Agostis tenuis
Alopecurus himalaicus
Avena fatua
Avena sativa
Bromus gracillimus
Bromus japonicus
Bromus lanceolatus
Bromus tectorum
Bromus tomentosus
Bromus stenostachyus
Calamagrostis dubia
Calamagrosits pseudophragmites
Colopodium afghanicum
Deschampsia caespitosa
Deschampsia koeleriodes
Elymus dahuricus
Elymus dasystachys
Elymus nutans
Eremopoa perisica
Festuca alaica
Festuca altaica
Festuca arundinacea
Festuca rubra
Hordeum brevisubulatum
Hordeum turkestanicum
Koeleria cristata
Lolium rigidum
Malacurus lanatus
Melica jacquemontii
Panicum miliaceum
Phleum alpinum
Phragmites australis
Puccinellia sevangensiss
Puccinella distans
Oryzopsis latifolia
Oryzopsis lateralis
Oryzopsis gracilis
Oryzopsis pubiflora
Oryzopsis purpurascens
Poa afghanica
Poa alpigina
Poa alpina
Poa Litwinowiana

Poa pratensis
Poa Roemeri
Polypogon monspeliensis
Secale cereale
Setaria viridis
Stipa barbata
Stipa caucasica
Stipa glareosa
Stipa mongholica
Stipa pennata
Stipa trichoides
Stipa splendens
Triticum aestivum

POLYGONACEAE
Atraphaxis spinosa
Oxyria digna
Polygonum arenastrum
Polygonum aviculare
Polygonum bucharicum
Polygonum convolvulus
Polygonum molliaeforme
Polygonummyrtillifolium
Polygonum sibiricum
Polygonum thymifolium
Polygonum paronychioides
Polygonum pyrifolia
Rheum tibeticum
Rheum spiciforme
Rumex Patientia
Rumex Paulsenianus

POTAMOGETONACEAE
Potamogeton amblyphyllus

PRIMULACEAE
Glaux maritma
Primula macrophylla
Primula pamirica
Primula Warshenewskiana

RANUNCULACEAE
Anemone biflora
Clematis Hilariae
Clematis orientalis
Delphinium afghanicum
Delphinium brunonianum
Halerpestes salsuginosa
Isopyrum anemonoides
Paraquilegia anemonoides
Pulsatilla campanella
Ranunculus alpigenus
Ranunculus longicaulis
Ranunculus natans
Ranunculus pamiri
Ranunculus pseudohirculus

Ranunculus rubrocalyx
Ranunculus rufosepalus
Ranunculus Shaftoanus
Ranunculus Trautvetterianus
Thalictrum alpinum

RUBIACEAE
Rubia tibetica
Rubia gedrosica
Rubia chitralensis
Galium tricornutum
Galium Vassilczenkoi

RHAMANACEAE
Rhamnus prostrata

ROSACEAE
Potentilla anserina
Potentilla argentea
Potentilla bifurca
Potentilla dealbata
Potentilla gelida
Potentilla multifida
Potentilla phyllocalyx
Potentilla sericea
Potentilla supine
Rosa Webbiana

RUBIACEAE
Galium ibicinum
Galium tricornutum
Rubia citralensis

SALICACEAE
Populus pamirica
Salix caesia
Salix excelsa
Salix iliensis
Salix pycnostachya
Salix schugnanica
Salix turanica

SANTALACEAE
Thesium himalense

SAXIFRAGACEAE
Saxifraga komarovii
Saxifraga hirculus
Saxifraga sibirica

SCROPHULARIACEAE
Euphrasia paghmanensis
Euphrasia secundiflora
Linaria bamianica
Pedicularis brevirostris
Pedicularis cheilanthifolia

Pedicularis dolichorrhiza
Pedicularis pulchra
Pedicularis rhinanthoides
Pedicularis uliginosa
Pedicularis verae
Scrophularia dentata