

Results of Argali Survey in Big Pamir and the Wakhjir Valley by the Marco Polo Sheep Survey Team 2008

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- 1) A comparison of the habitat data points revealed that grassy habitats in the Wakhjir were greener than grassy habitats in the Big Pamir as determined by extracting habitat location values from an NDVI layer (Figure 2). Greenness is positively correlated with grass nutritional quality and/or quantity, so this result indicates that the Wakhjir rangelands likely offer superior forage for both livestock and wildlife. This finding corresponds well with visual assessments provided by both Bedunah, Habib, Moheb, and Schaller on prior expeditions. There was a similar, although not statistically significant result when comparing sedge greenness between the two regions, with sedge locations being greener in the Wakhjir than in the Big Pamir (Figure 3).
- 2) The above observations are reinforced when male horn growth rates based on measurements made on skulls are compared between the two regions (Photo 2). On average, Wakhjir rams average 20% greater horn growth (in length) than rams in the Big Pamir of the same age, suggesting higher levels of nutrition (Figure 4).



Photo 1. The Afghanistan-China border on Wakhjir Pass. Afghanistan is on the right. The fence spans approximately 1km across the lowest point on the pass, and ends abruptly behind the photographer, and on the slope in the upper left of the photo.

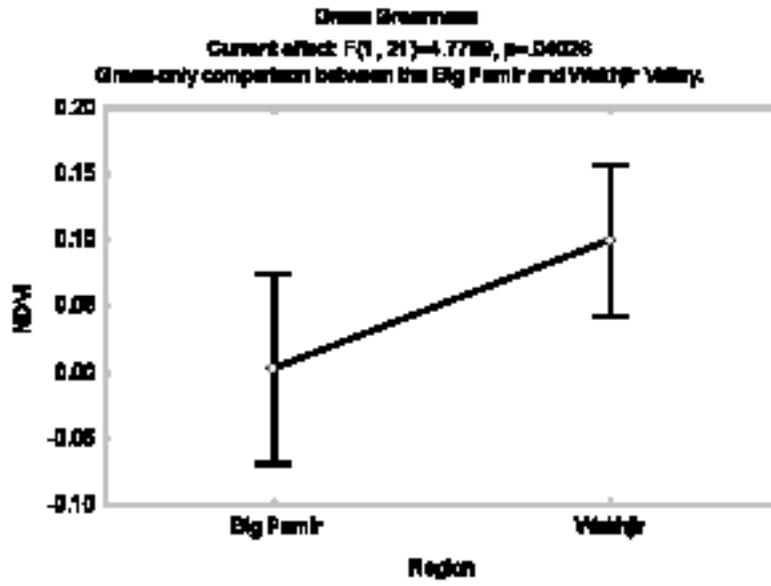


Figure 2. Grass habitat points are significantly greener in Wakhjir than in the Big Pamir.

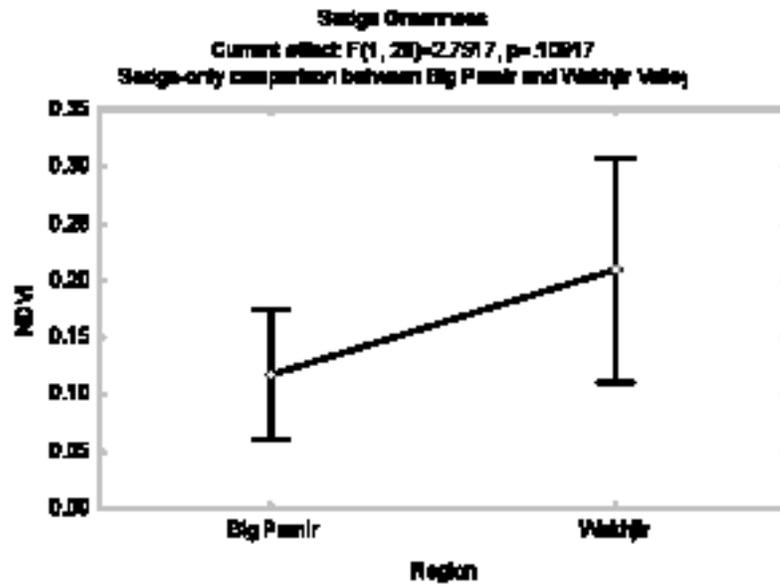


Figure 3. Sedge habitat points appear to be greener in the Wakhjir than in the Big Pamir, but the difference is not statistically significant.



Photo 2. An argali ram skull with 157.5 cm (5' 2'') per side horns in the upper Wakhjir Valley.

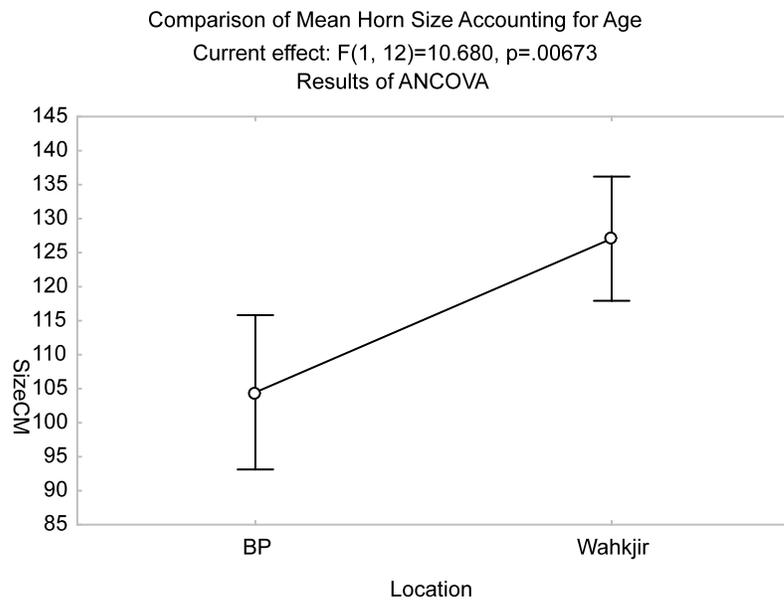


Figure 4. Ram horn growth in Wakhjir is approximately 20% faster than in the Big Pamir.

3) The summer (June – early July) lamb-ewe ratio in 2008 in the Big Pamir was 43 lambs per 100 ewes. This is low for so early in the season, and may be due in part to precipitation: while central Afghanistan received heavy snowfall in the winter of 2007-2008, by all local accounts, the Big Pamir was exceptionally dry. This was reflected in the actions of herders who would normally keep their sheep in the Big Pamir until late September or early October, instead moving their flocks down to markets in late June and early July due to lack of forage. By comparison, in the Wakhjir Valley, the October lamb – ewe ratio was 66 lambs per 100 ewes. This difference in lamb-ewe ratios suggests that in 2008 early lamb survival was substantially higher in the Wakhjir (particularly since the Wakhjir ratio was calculated 3 months later in the season – thus with three additional months of mortality - than the Big Pamir).

4) On prior expeditions to the Big Pamir, the team noted that argali tended to shift from using sedge meadows in the spring and summer to predominantly south-facing grassy areas in the fall and winter. South-facing slopes contain both grassy areas and sedge meadows, but argali appeared to avoid the latter in the late fall and winter. One possible reason for this is that sedge meadows, also a preferred summer foraging area for domestic yaks in the summer, are depleted by the fall, forcing argali to shift their diet to grass. The Wakhjir trip provided an opportunity to test this hypothesis because it is largely un-grazed by domestic livestock through the summer and fall, and has abundant wet sedge meadows. All argali that were seen feeding in the Wakhjir in September and October 2008 were in grassy areas despite many large areas of lightly- or un-grazed sedge meadows (Photo 3). Also, roughly 90% of the argali seen by the team were on the south-facing slopes on the north side of the valley.



Photo 3. A large group of argali rams on a south-facing slope in the Wakhjir Valley. The group was grazing the grassy slopes in the foreground before moving up towards the talus in the background in response to the expedition's approach.

The sedge meadows in Wakhjir Valley were palatable to the team's yaks, and when turned loose, they never ventured outside of these meadows despite adjacent areas of grass. It should be noted that virtually all areas of grass contain substantially less biomass than the sedge meadows (conservatively, 1 to 2 orders of magnitude less). The grasses tend to be bunch grass (e.g. *Festuca* spp.) that are low-lying (typically no more than 20 cm tall) and widely separated (30 to 100 cm) (Photo 4), whereas the sedge meadows are often several hectares of dense, continuous vegetation 30 to 60cm tall (Photo 5).

It is likely that as the sedges and grasses dry in the late summer and early fall, the ratio of digestible to indigestible material in sedges shifts to a point where a smaller ruminant such as an argali can not maintain a positive energy balance while consuming this food, whereas much larger bulk feeders such as yaks, can (Maxwell and Lavin, personal communication).

5) NDVI values extracted from the habitat points are excellent predictors of the 3 classes of argali habitat: Talus and steep scree (often used as bedding areas or escape terrain, Photo 6); grass (feeding and occasionally bedding areas) and; sedge meadows (used almost exclusively as feeding terrain, primarily in spring and summer), (Figure 5). Descriptions of argali locations were used to confirm that the model was indeed predicting habitat types accurately and the results were similar to those achieved using the habitat points (Figure 5).



Photo 4. A grassy slope near the Afghanistan – China border on which the team observed argali grazing.



Photo 5. Large expanses of sedge meadow in the Wakhjir were lightly- or un-grazed.



Photo 6. A group of argali rams using a steep talus slope as escape terrain in the upper Wakhjir near the Afghanistan – China border.

NDVI values at Big Pamir argali locations showed the same pattern as did the habitat points, but were did not differ from each other at the 0.10 level (Figure 6). This is likely due to differences in how the field personnel and argali sampled the different habitats: the researchers moved well into the middle of habitat patches to ensure that the point would fall into a discrete 30 by 30m pixel in an NDVI layer. Argali, however, frequently foraged near the edges of the habitats, where habitat types began to grade into each other, thus yielding greater variance in the NDVI values at those points (this is reflected in the wide confidence intervals seen in the vertical bars in figure 6). Note that the team made no observations of argali in sedge meadows while surveying the Wakhjir Valley and only one observation of argali in talus, so were unable to run the same comparisons across the 3 habitat types for the Wakhjir argali locations.

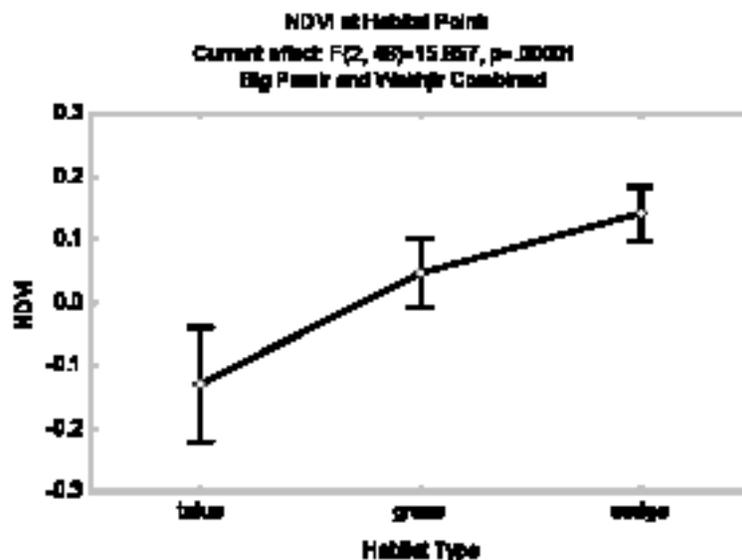


Figure 5. NDVI distinguishes well between talus, grass, and sedge.

The above data correspond well with the team’s field observations: argali often bedded in talus slopes immediately above (within 20m of) sedge meadows or grassy areas, and frequently grazed the edges of sedge meadows adjacent to talus slides. Furthermore, argali frequented sedge or grass “green bands” on mountain slopes. These bands run vertically, are often less than 50m in width and usually bordered by scree and talus.

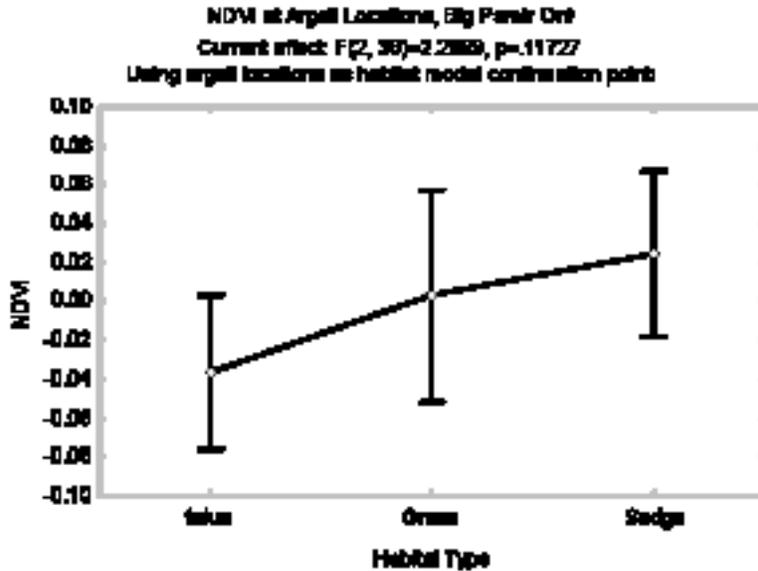


Figure 6. NDVI at Argali locations has more variance than habitat points (see text).

6) The Kyrgyz leave the Wakhjir Valley early every spring, moving their livestock to summer pastures. Except for a few yaks and Bactrian camels in the lower valley, argali have free reign over most of the Wakhjir from late April until November. During this time, forage species (grasses and sedges) appear to accumulate substantial biomass without the grazing pressure of the 2000 plus (based on Kyrgyz herder estimates) head of domestic livestock that winter in the valley. The relatively small argali population that utilizes the valley, combined with abundant, higher quality (than the Big Pamir, see #1 above) forage may be sufficient to explain the differences in ram horn growth (#2 above), and the differences in early (June to October) lamb survival (#3 above). Both of these responses tend to be positively correlated with range quality. However, in November and December, the Kyrgyz move livestock into the Wakhjir. Virtually all Kyrgyz iloks are on the south-facing slopes, and according to locals, the argali move from these areas to the opposite, north-facing slopes. The fact that argali stay on south-facing slopes throughout the winter in the largely unoccupied Big Pamir, indicates the shift in habitat in the Wakhjir is likely caused by the presence of the Kyrgyz and their settlements. North-facing slope tend to accumulate more snow (confirmed by the Kyrgyz – this is why they put their settlements on the south-facing slopes), but despite this, the Kyrgyz run substantial numbers of yaks, sheep, goats, horses, and Bactrian camels on both the north- and south-facing slopes.

Thus, during the growth and birthing seasons (spring and summer) argali appear to have access to abundant, high quality forage, leading to higher growth rates and higher early lamb survival than the Big Pamir. However, during the winter, when animals are nutritionally stressed and one expects most natural mortality to occur, Wakhjir argali are pushed to north-facing slopes and face direct competition for forage from Kyrgyz livestock.

The situation appears somewhat different in the Big Pamir. In the early spring, argali frequent sedge meadows and appear to have some moderate competition from unattended yaks. As summer progresses, Wakhi herders drive their sheep and goat herds (and some additional yaks)

ever higher up the valleys and onto ridges. Argali responded strongly to the presence of herders, leaving high quality, green sedge meadows and foraging at ever higher elevations in areas supporting lower sedge density, or left drainages altogether in an apparent attempt to avoid people and livestock as well as find forage. By the time fall arrives, livestock herds are usually high in the valleys and on the ridges, and the Wakhi then begin to retreat down to lower elevations. During this retreat, the livestock herds crop the remaining forage, which is now senescent. These last areas grazed by livestock in the fall, are argali winter range. As snows accumulate, argali shift their range down the valleys and encounter range that have recently been heavily grazed – in some areas, livestock numbering in the tens of thousands have moved through argali wintering areas late in the fall, each animal grazing as it is herded through.

The preceding scenario paints a bleaker picture for Big Pamir argali. During the summer growth and birthing season, they face competition from Wakhi livestock and frequent disturbances as herders move herds around and between valleys. In the winter, while not facing direct competition from Wakhi livestock, argali face a kind of delayed forage competition: grass on argali wintering range has been consumed by domestic livestock throughout the late-summer and fall and does not have a chance to re-grow before winter. Thus when snows push argali down to wintering areas, they enter a region that has recently been heavily grazed by thousands of sheep, goats, yaks, cattle, horses and camels.

The impression that the Big Pamir vegetation is badly depleted by livestock has also been noted previously by Bedunah and Schaller: the Big Pamir presents a much bleaker and more heavily trampled landscape than the Wakhjir – a lower quality environment for both livestock and wildlife.

7) The MPS research team is continuing work with the Kabul office staff and WCS New York staff to procure a 30m digital elevation model (DEM). WCS New York staff have made contact with personnel at the USGS and learned that NASA has produced a 30m DEM of the Wakhan using data from the Shuttle Radar Telemetry Mission (SRTM), but given the political sensitivity surrounding the region is currently unwilling to provide it to WCS. Kabul and New York staff are trying to arrange procurement of the 30m DEM through USAID. Parallel to this effort, Kabul GIS staff are making a trial run of generating a 30m DEM from ASTER data. ASTER images are problematic, requiring extensive georeferencing in 3 dimensions.

Preliminary attempts to model argali escape terrain using the readily available 90m SRTM DEM have been equivocal at best, and absent a higher resolution (30m) DEM, the strength of inferences that can be made about the locations of suitable argali habitat and likely dispersal corridors based on these models, will be reduced.