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Fakhar -i- Abbas
Bioresource Research Centre, Isalamabad, Pakistan, fakharabbas@hotmail.com

Afsar Mian
Institute of Natural and Management Sciences, Rawalpindi, Pakistan

Tanveer Akhtar
Department of Zoology, University of Punjab, Pakistan

Thomas P. Rooney
Wright State University - Main Campus, thomas.rooney@wright.edu

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STATUS AND FUTURE MANAGEMENT OF GREY GORAL (*NAEMORHEDUS GORAL BEDFORDI*) IN PAKISTAN

Fakhar-i-Abbas[1*], Afsar Mian[1,2], Tanveer Akhtar[3], Thomas P. Rooney[4]

[1] Bioresource Research Centre, 34 Bazar Road G-6/4 Islamabad Pakistan.
[2]Institute of Natural and Management Sciences (INAM), Rawalpindi, Pakistan.
[3] Department of Zoology, University of the Punjab, Lahore, Pakistan.
[4] Department of Biological Sciences, Wright State University, 3640 Colonel Glenn Hwy., Dayton OH 45435 USA.
[*]Email: fakharabbas@hotmail.com

ABSTRACT

Himalayan grey goral (HGG: *Naemorhedus goral bedfordi*) is endemic to Himalyas and regarded as Endangered/ Threatened. Study was designed to collect information on population biology, habitat, food and behaviour of population of HGG distributed in Pakistan, trying to understand its present status and conservational potentials. Our data suggest that the population, habitat and the species has sufficient potentials for its survival in the area, if protection from human predation is afforded to the species. HGG population is isolated into 7-8 subpopulations and is facing male-biased mortality, therefore is likely to face bottleneck effects and subsequent population crash ascribed to loss of males and genetic diversity. HGG population has a slow growth rate, attributable to internal species potentials and the natural predation of fawns/ sub-adults, which is difficult to be enhanced therefore range management strategy is suggested as management solution, with emphasis on protection from hunting, habitat management, mass awareness and supportive research. International cooperation is suggested as part of HGG population extends into Indian part of Himalayas, including Indian Kashmir.

Key words: Species potentials, habitat potential, population potentials, management.

INTRODUCTION

Himalayan grey goral (HGG: *Naemorhedus goral bedfordi*, order Artiodactyla, sub-order Ruminantia, family: Bovidae, class: mammalia) is a small antelope-like goat, endemic to the Himalayas (Zhiwotschechenko, 1990; Singh and Singh, 1986) distributed from north Pakistan, through north India, Nepal, Bhutan to Mishi Hills in Mynanmar at 2,00-4,000 m above sea line (asl) (Grubb, 1975; Schaller, 1977, Prater, 1980; Jhonsingh, 1992; Roberts, 1997). US Fish and Wildlife Service regards HGG as Endangered (USFWS, 1989) and IUCN as Near Threatened (IUCN, 2001). Pakistan holds about half of the present global population of HGG (Anonymous, 1989), and wildlife enthusiasts and managers regarded this population as Vulnerable (Shiekh and Malour, 2004). Future survival of HGG requires serious management efforts, based upon analysis of existing status of its population. This paper attempts to

develop a guideline for a continued survival of HGG population in areas under Pakistan.

For the purpose, we developed a multi-prong strategy to collect information on HGG biology with reference to the area under present analysis (reported as Fakhar-i-Abbas et al., 2008, 2011, 2012). We carried out an extensive survey of northern hilly parts of Pakistan, contacted local hunters, prominent persons, grazers and wildlife field staff for their recent HGG sighting and also searched each tract for indirect HGG indicators, like, foot prints, hair, etc.. We selected tracts having HGG population for detailed studies, which fell in 7 administrative regions, viz., Mardan, Bunner, Islamabad, Abbotabad, Mansehra, Kohistan and Azad Kashmir (Figure 1). We conducted transect (50 m, 9-10 in each stand) sampling in 51 stands following Cox (1990) to establish vegetative types using TWINSPAN (a DOS based computer programme) for HGG habitat potentials. We used variable quadrat sampling (scanning a circular area around some cliff for HGG; Volshina, and Nesterov 1992) in 98 stands during different seasons and recorded number, sex and age of HGG observed and calculated population densities using estimates on optimally scanned area, and developed HGG population estimates, sex structure and age structures for different areas. HGG population densities were associated with biotic and abiotic habitat variables. We also collected HGG faecal pellets (n =15) and analyzed these using micro-histological techniques (Holechek et al., 1982) for general analysis of HGG feeding preference. We determined water, protein, fat, sugar and ash contents of each food species using chemical method (Anonymous, 1963) and used these to draw inferences on HGG energy and water budgeting. We conducted round the clock observations on a stock of semi-captive flock of HGG, for analysis of time budgeting, supported with limited general field observations.

Based upon information on HGG distribution and biology, we worked out future survival potentials of HGG population in Pakistan, and proposed future management strategy workable in Pakistan.

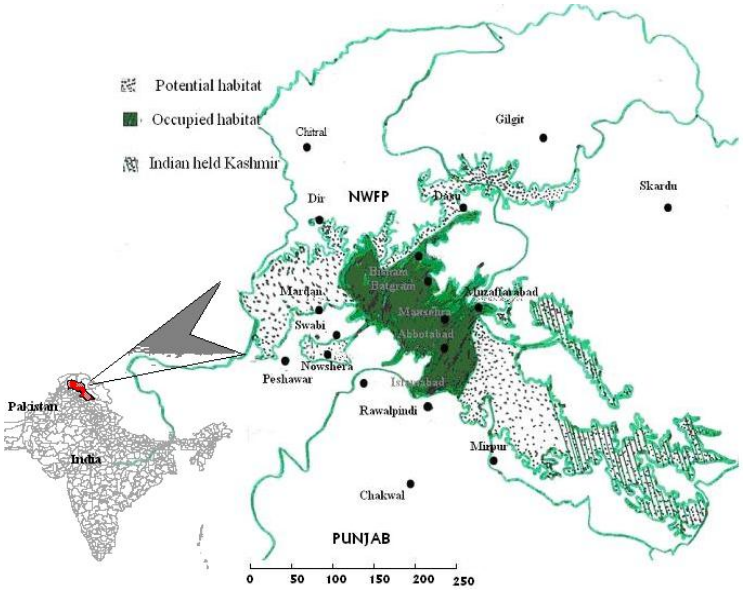

Figure 1: Potential and present distribution of HGG in Pakistan.

GORAL BIOLOGY

Our research data (Table 1) suggested that during 2004-06 a population of 681 (600 - 800) HGG was present over some 4,839 km^2 (5,000

km^2) of potential habitat of Himalayan hills extending into Pakistan with average density of 0.15 ± 0.02 (SEM) heads km^{-2}. Major part of this population (around 350) was present in Azad Kashmir (200) and Bunner (153). Female/ male sex ratio of 1.92 indicated preponderance of females in adult population. We recorded an average of 0.31 sub-adults per adult female, and sub-adult/female ratio was the highest in breeding season (February-March; 0.50), which gradually dropped to 0.11–0.17 in November-December. This allowed us to propose a lamb survival rate of 22-34% during the first year of the life. Mean herd size was 1.72 ± 0.11 (SEM), having larger herds in summers (1.96 ± 0.16, SEM) compared to winters (1.38 ± 0.10, SEM), suggesting solitary nature for HGG though individuals may aggregate into small groups (Fakhar-i-Abbas et al., 2012).

Table 1: Distribution and structure of HGG population in different broad localities of Pakistan and AJK during 2004-06. M= male, F= female, Sub= sub-adult, Pop= estimated population (abridged from Fakhar-i-Abbas et al., 2012).

Locality		Habitat Area (km^2)		Gorals Observed (#)*				Average Density (km^2, ±SEM)	Pop (#)	Ratio	
Major	Minor (#)	Total	Sampled	M	F	Sub	T			Sex(F/ M)	Subadult/ Female
Abbotabad	11	515	109	2	3	2	7	0.06±0.03	41	1.50	0.66
Mansehra	15	909	209	6	13	5	24	0.14±0.06	100	2.17	0.38
Mardan	9	324	100	11	10	5	26	0.27±0.07	85	0.91	0.50
Bunner	10	409	129	14	27	8	49	0.38±0.10	153	1.93	0.30
Kohistan	5	875	84	1	2	1	4	0.050.03	53	2.00	0.50
Margalla	6	181	42	2	7	2	11	0.25±0.09	49	3.50	0.29
Kashmir	16	875	223	12	32	6	51	0.21±0.06	200	2.46	0.29
Overall	102	4088	896	49	94	29	172	0.15±0.02	681	1.92	0.31

Phytosociological studies on habitat suggested presence of at least 99 endospermic plants species, with three well defined layers, i.e., tree (22 species), shrub (25), herb (21) and grasses (21). *Pinus roxburghii* was the most widely distributed species. Most species showed a low constancy of appearance. Eight (8) vegetative types were identified through TWINSPAN analysis (Table 2). This indicated diversity in the habitat exploited by HGG in different parts of its distribution range. HGG density in different vegetative types was different; attributable to available physic-biotic conditions. Herb (y= 0.005X + 0.1718; R^2= 0.5446) and shrub (Y = 0.007X + 0.1407; R^2= 0.5369) cover had a positive association, while trees had a negative association (Y = - 0.006X + 0.472; R^2= 0.7136) with HGG density. HGG population moved to lower altitudes (800 - 2,200 m asl; peak at 1,200 m) during winter and to higher altitudes (1,400 - 2.600 m asl; peak at 2,100 m)

Table 2: Composition, location and HGG density (±SEM) in different vegetative types in Goral habitat in Pakistan and AJK. A= *Acacia modesta-Dodonaea viscose,* B = *Olea ferrugonea-Acacia modesta,* C = *Dodonaea viscose-Pinus roxburghii,* D= *Dodonaea vicosa-Pinus roxburghii-Myrsine africana,* E= *Carissa opaca-Anthraxon prionodes,* F= *Pinus roxburghii-Carissa opaca,* G= *Stipa sibirica,* H= *Pinus roxburghii-Brachypodium sylvaticum,* Pro = Proportion of available HGG habitat (abridged from Fakhar-i-Abbas et al., 2008).

Veg. Type	Herb		Shrub		Tree		Total		Altitude (m)	Distribution		HGG density (km^{-2})
	#	Cover (%)	#	Cover (%)	#	Cover (%)	#	Cover (%)		District	Pro (%)	
A	14	28.9±3.1	4	37.4±7.2	9	37.4±7.2	27	90.0 ± 3.2	800-1750	Mardan	6.6	0.24±0.12
B	13	22.6±2.3	4	25.5±2.3	6	23.9±3.8	24	72.0±3.4	650-1180	Mardan	4.3	0.23±0.05
C	16	14.7±4.3	7	29.5±6.5	5	40.8±3.4	27	95.1±7.3	700-2600	Mardan, Bunner	15.1	0.41±0.08
D	33	22.6±1.4	21	33.1±2.2	19	33.1±2.2	73	85.6±1.8	800-2600	Mardan, Bunner,	50.6	0.50±0.10
E	23	45.1±9.1	7	28.2±6,7	6	9.3±2.6	36	82.6±0.3	1200-2000	Kashmir	4.0	0.39±0.10
F	22	44.3±7.0	5	22.6±3.0	7	17.2±6.6	34	84.1±2.1	1100-3000	Mansehra, Centre Kashmir	12.8	0.26±0.04
G	22	52.8±2.8	4	16.3±2.6	2	6.5±2.7	29	75.6 ±2.5	133-2600	South Kashmir	3.4	0.70±0.30
H	23	55.3±0.12	6	20.±0.05	2	13.±0.04	31	89.±0.15	1100-2000	South Kashmir	1.4	0.12±0.14

Table 3: Relative consumption of different broad food types and preference by HGG in Pakistan (abridged from Fakhar-i-Abbas et al., 2012).

Type	Consumed		Availability (% cover)	Preference index (consumed/ availability)
	Species (#)	Proportion (%)		
Tree	3	1,15	11.17	0.10
Shrub	13	36.07	10.80	3.31
Herbs	12	62,76	6.14	10.27

during summer (Fakhar-i-Abbas et al., 2012).

Faecal pellet analysis and field observations revealed that HGG consumed a minimum of 28 plant species, with tree: shrub: herb appearing in the ratio of 1: 31: 55 (Table 3). The species mainly (59%) subsisted on 6 grass species (*Chrysopogon aucheri, Themeda anathera, Poa pratensis, Digitaria decmnens, Apluda mutica, Aristida cyanatha*), though leaves of shrubs (*Myrisine africana, Daphne oleoides, Carissa opaca, Rubus elipticauli*) also contributed appreciable part (31%). Food species preference index (consumed/ available) suggested that *Chrysopogon aucheri* (112 X), *Digeteria decumbens* (62 X), *Apluda mutica* (50 X) and *Rubus ellipticus* (49 X) and *Themeda anathera* (29 X) were preferred by HGG. Food species on the average provided 77.8 ± 2.6% (SEM) water, 8.6 ± 0.4% (SEM) ash (minerals), 6.8 ± 0.7% (SEM) carbohydrates, 5.6 ± 0.2% (SEM) proteins and 1.3 ± 0.1% (SEM) fats. Average food provided 4,440 kcal (around 4,500 kcal) of energy and 5.45 L of metabolic water per day to adult HGG (adult: 25-28 kg, Primrose, 1911), which was sufficient to meet its regular requirements (Fakhar-i-Abbas et al., 2008).

Studies on behavior of semi-captive HGG stock revealed that sub-adults spent 33%, 12%, 22%, 14% and 8% of time while sleeping, ruminating, resting, feeding, and in agonistic activities, respectively. Adults spent lower proportion of time while sleeping (25%), resting (14%) and feeding (8%), and higher proportion in ruminating (26%) and agonistic activities (13%) compared with juveniles. HGG spent major part of night while sleeping, has a crepuscular feeding behavior and goes for day time rest during hotter parts of the day. Field observations indicated that HGG remains vigilant to environmental changes while feeding, ruminating and resting. HGG preferred drinking from source of running water rather than from a stagnant water body. HGG depended upon camouflaging and threat behavior for defense (Fakhar-i-Abass et al, 2011).

SURVIVAL POTENTIALS

More detailed studies are required for a better understanding of HGG biology. However, on the basis of results of the present study, we developed some insight into the present status of HGG population of Pakistan. The survival potentials of HGG population can be viewed from three aspects, i.e., population status, habitat potentials and species potentials.

a. **Population status:** With presently collected data we suggest the presence of 600-800 HGG distributed over some 5,000 km^2 of potential favourable HGG habitat tracts with overall density of 0.15±0.02 km^{-2}. Because HGG populations was not present in some areas despite holding favourable habitat, we conclude that during 2003-2006 HGG was present over 3,025 km^2 with overall density of 0.27±0.05 km^{-2}. We did record some high population densities for certain populations (1.08/ km^{-2} for Nawa Kal, Bunner; 1.0 for Titalbar, Azad Kashmir) surviving in isolated patches indicating that HGG can tolerate higher densities if

habitat conditions allow. Himalayan goral (*Naemorhedus goral)* is endemic to Himalayan range and the sub-species *N. g. bedfordi* (Himalayan grey goral) is limited to the western flanks of the species distribution range (Shackleton, 1997). Precise estimates on HGG populations present in adjacent parts of India and Indian part of Kashmir are not available. Reports from the Indian part of HGG distribution range suggested that HGG populations were largely limited to sanctuaries and protected forests (Roy et al., 1995; Pendharkar and Goyal, 1995; Mishra and Johnsingh, 1996; Ilyas, 1998). Cavallini (1992) reported absence of HGG in 10 sanctuaries in Himachal Pradesh (India). Pedharkar and Goyal (1995) reported densities of 0.31-0.36 km^{-2} for different tracts of Simbalbara Sanctuary (Himachal Predash, India) without attempting population estimates. With the population of around 700 HGG distributed in general unprotected or poorly managed protected areas with densities equivalent to those recorded for one of the sanctuaries of India, we propose that HGG population was in reasonably happier state along the distribution range of the subspecies/ species extending into Pakistan. However, this population requires a care, if the subspecies/ species are to be saved for the future generations. There are indications to suggest a rise in HGG population of Khyber Pukhtoonkhwa (KPK, Pakistan) under protection Safdar Shah, Conservator Wildlife, KPK, 2013; personal communication).

We do not have data on the decline rate in HGG population. The KPK Wildlife Department conducted HGG population census for some selected areas (Anonymous 2000, 2000a, 2003). These census estimates of HGG were fairly close to the population estimates for respective tracts under our present study. Considering the reasonable proximity of the population estimates for 2000-2003 period and 2003-2006, we propose a stability of HGG population over the recent year in KPK. We believe that HGG population in the area is trying to stage a comeback under protection afforded by KPK Wildlife Departments. However, with the complete absence of HGG populations in some of its previously reported range {Himalaya and Hindukush at 800-2,500 m above sea level, Stebbins, 1912; Cherat, Murree Hills, Dir, Swat, Roberts, 1997; absent from otherwise suitable tracts, Fakhar-i-Abbas et al. 2012)} we propose a contraction in HGG distribution range, indicating a decline in HGG population during the last century. Collective consideration of the two facts suggests that sufficient habitat is still available in the area to support a spillover of HGG populations at a stage when it exceeds the carrying capacity level of the existing HGG distribution range.

Considering 2003-2006 distribution (Figure 1) we propose that HGG population is spatially divided into 7-8 subpopulations, isolated through geographic and habitat barriers. Analysis on level of isolation between such subpopulations requires studies using molecular markers, but with the present information we presume that isolated smaller subpopulation can lodge into serious consequences under the bottle-neck effect and genetic fixation. We

recorded female biased sex ratio, caused by partial mortality of males, which can be an indirect indicator of hunting pressure (Mishra, 1993; Forsyth, 1999; Topp et al., 2009). Goral is polygamous (Owen-Smith, 1979; Gosling, 1986; Myslenkov and Voloshina, 1998) therefore imbalanced sex ratio is not expected to have serious consequences in general recruitment potentials. However, the effect of such imbalanced sex ratio can have serious consequences in the smaller populations, which can play havoc if the environmental stresses exceed certain limits. Fewer number of males adding into population gene pool may also result in narrowed population genetic diversity, facilitating population genetic fixation.

Direct data on reproductive biology and population growth potentials are not available. However, our data suggest 0.50 fawns per female in late spring/ early summer, declining to 0.11-0.17 during winter. With this information we propose that a minimum of 0.11 fawns per female survived the first crucial year of their life. Keeping in view the female biased sex ratio, we estimated a minimum of 0.072 fawns/ adult being added annually in the population, i.e., annual addition of 7.2% into the population. Believing the average life span of HGG is 14-15 years (Hofmann, 2004), we expect an annual natural mortality of 6.7-7.1%. Considering the two facts together, we suggest an annual HGG population growth rate of 0.06-0.54%. This growth rate is very low, yet is reasonably good with goral standards (producing one fawn/ female/ year; Hofmann, 2004). The proposed growth rate, however, does not take into account the mortality coming from human predation.

Judging the present status of HGG under IUCN criteria (Anonymous, 2001) we propose that HGG population maintained a Vulnerable status, with a population of <1,000 fragmented into 7-8 isolated subpopulation. We do not have information on status and distribution of HGG population in Indian Kashmir. Even if this population is continuous with HGG population of Pakistan and total numbers exceeds 1,000 limit isolation between subpopulations still persists and HGG maintains a Vulnerable status. Population isolations can have serious consequences in a female biased population, where fewer males add into population gene pool and population crash becomes more eminent under complete absence of males. With this status, we believe that population of HGG requires protection to ensure its continued survival.

b. Habitat potentials: HGG is associated with *Pinus roxburghii* and prefers habitat with sufficient open area with ledges of steep rocks. However, there is a high degree of heterogeneity in vegetative composition in HGG phyto-habitat, indicated by high species diversity and low constancy of appearance for different species. We believe that this attributes stability to habitat ensuring continued HGG survival under future natural odds (emerging problem of dieback in *Pinus* sp.??) and deforestation. The area receives sufficient precipitation to support growth of herbs and shrubs, ensuring food and shelter for HGG. Natural springs and

streams of freshwater ensure the continued supply of running water, liked by HGG. We could not find any evidence indicative of habitat causing a serious problem for survival of the present population of HGG, and believe that available habitat has potentials of holding even a larger population of HGG than the one held in 2004-2006.

Under the existing trends, we feel that HGG potential habitat area (falling at lower altitudes close to human habitation) will in coming years face a heavier grazing and wood cutting stresses, resulting in shrinkage in habitat resources/ area. As trees are not directly being exploited by HGG species for food or shelter, therefore we believe that HGG will be able to adjust limited degree of habitat degradation, caused through logging. Shrub cover though does not appear to affect HGG density, yet this is required for the protection of the fawns (Pyrah, 1974). HGG is more likely to face increased competition from sheep/ goat grazing herds, which are ever increasing with increasing human population, their aspirations for better living standards, and consequent economic needs of the people. However, arduous rocky habitat, preferred by HGG, is often not exposed to serious grazing stress from livestock, goat having potential to exploit arduous tract being a browser.

c. Species potentials: HGG is fully adjusted to survive under the available conditions of HGG areas distribution in Pakistan. The species has a broad feeding niche, basically depending upon grazing grasses but can subsist upon available herbs, shrubs and even lower branches of trees, under the odd conditions. It has an extended spatial niche, achieved through movement of its populations between different altitude during summer and winter, allowing a relief to its habitat under harsh environmental conditions. HGG also exploits an extended hyper-volume niche, selecting valleys for grazing and open rocky ledges/ peaks for rest.

HGG exhibits sufficient behavioural adjustment to ensure its survival. Cautious nature HGG, both during grazing and rest, camouflaging colouration, crepuscular feeding habit, males exposing to predation to save females and restoring to threat behaviour to find an escape from predator, collectively ensure optimal surviving conditions for this species. The fact that loose groups of HGG can live over 50 ha and males mark territory over 22-25 ha (Hofmann, 2004) suggested that a much larger population can be held over the presently available habitat. HGG has potentials to adjust its herd size in accordance with available conditions, a smaller herd size during winter when food resources are scarce, lowering intra-specific feeding competition and stress on vegetation resources.

We could not find serious potential predators for adult HGG, though fawns face a higher predation. Leopard (*Pathera pardus*) would be effective predator for adult HGG, yet its present population of this predator is limited. Wolf (*Canis lupus*), jackal (*C. aureus*) and some raptors can predate fawns. We presume that major part of 66-78% fawn loss during the first year of life is claimed by such predators during

summer. However, stable HGG populations recorded in protected areas indicate potentials of HGG to amicably face natural fawn loss. Populations of these predators have, however, started increasing with the help of community based conservation.

d. **Future Threats:** Considering these facts together, we propose that HGG has sufficient potentials of its continued survival under natural conditions of the area. However, distribution range of HGG falls within an easy access of human population. Anthropogenic activities of ever increasing human populations, its demands for better amenities of life, and increasing livestock grazing and wood cutting pressures are the potential threats for HGG habitat and privacy. Gradually extending communication links and means of transportation can be the additional threats for HGG future survival.

MANAGEMENT

With the present analysis, we propose that HGG population surviving in Pakistan and AJK has sufficient survival potentials due to: a). reasonably good geographic range of distribution, b). many sub-populations surviving under different habitat conditions of different tracts, c). stable or slightly increasing populations under the present regimen, d). smaller home range/ territory, and potentials of amicably sustaining certain degree of aggregation under environmental odds, e). reasonable population density distribution with goral standards, f). seasonal movements and extended hyper-volume niche, g). wider food preference and consuming grasses, herbs and shrubs, and h). no or very limited predation/ hunting stress. We regard HGG population as Vulnerable to extinction, because, 1). present population is small (<1,000), and 2). fragmented into 7-8 smaller isolated subpopulations, which can have serious consequences under future changing environmental conditions, attributable to human interference in habitat and privacy of HGG. Turning this HGG population into a viable population therefore requires increasing its size (>1000 heads) and breaking isolations between subpopulations. Increase in population size is difficult as presently recruitment rate into the population is almost equal to the expected natural mortality, and we expect an annual growth rate of only 0.01%. This low growth rate is attributable to low HGG recruitment potentials (single birth/ annum) and high fawn mortality (10-15% surviving first year of life). Low recruitment potentials are species specific and can hardly be increased. Fawn survival rate can be increased under a better protection and habitat management, to enhance natural growth population rate. Sufficient number of protected areas has already been declared within HGG distribution range, therefore creation of additional protected areas will have no appreciable effect on HGG population built up. Better protection and management will, however, be required in the existing protected areas. HGG, being distributed within better human populated tracts, will require effective public participation in future conservation measures.

Future survival of HGG requires continued protection, with special concentration on HGG population of Azad Kashmir. The isolation between populations also needs broken through development of habitat corridors and active translocation of males between populations. We expect continuation of Azad Kashmir HGG population with HGG population in Indian Kashmir. This demands international cooperation in research and management of HGG. Habitat limitation being not immediate problem, but keeping to future trends habitat management plan needs to be organized. Mass awareness campaign and organization of conservation clubs in schools and general community is also required for, not only, saving HGG but also the other wildlife species and the vulnerable Himalayan mountain landscape. Research on population level for monitoring population growth, level of isolation between subpopulations using mDNA, habitat monitoring for analysis of HGG carrying capacity, tracking population movement for possible identification of ecotypes and ecotype identification using molecular markers (barcoding) is required to support management strategy.

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