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# Habitat Use and Conservation Threats of Satyr Tragopan in Jigme Dorji National Park

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**Abstract**

Jigme Dorji National Park (JDNP) is the second largest national park in Bhutan. Satyr tragopan (*Tragopan satyra* Linnaeus), which is a near-threatened species according to the IUCN, is found in JDNP between an elevation range of 1800-4500 m. However, developmental activities are thought to be exerting pressure on its habitat. Therefore, a study was conducted to assess the habitat use and conservation threats to Satyr tragopan in JDNP. There was a significant association in the use of habitat types, preferring mostly oak and juniper forests of east and southeast aspects ($p < .05$) and the slope of habitat ranged between 0° and 40°. There was no correlation between number of Satyr tragopan and factors such as elevation, canopy cover percent and shrub cover percent ($p > .05$). There was also no association between plant species diversity and Satyr tragopan numbers ($p > .05$). Tree felling and poaching were the most common threats of Satyr tragopan in JDNP. An area of 1,018.81 km$^2$ is suitable as habitat for Satyr tragopan in JDNP. We propose that conservation of oak, fir and alder forests is very important as winter habitats of Satyr tragopan and requires further studies on habitat use patterns in other seasons as well for effective conservation of this species.

**Keywords:** Conservation, habitat preference, Satyr tragopan, threats

## Introduction

Among 51 species of pheasants recorded worldwide, 50 are of Asian origin (Zaman, 2008; Fuller and Garson 2000). Local communities exploit almost all the pheasant species in their native habitats. They are hunted mainly for food and for economic improvement (Simiyu, 1998; Zaman, 2008). Fuller and Garson (2000) mentioned that pheasants are associated with social and religious status of people in Asia and Europe. For instance, their feathers are used for rituals and local ceremonies in some areas of Pakistan.

Satyr tragopan (*Tragopan satyra* Linnaeus) is one among several types of pheasants found in Bhutan, which is near threatened according to Birdlife International (2011). Geographically, Satyr tragopan is found in the central and eastern Himalayas in Nepal, India, China, and Bhutan. Madge and MacGowan (2002) estimated that the global population of Satyr tragopan is fewer than 20,000 individuals. Although there is no data on population trend, hunting and habitat degradation are suspected to be causing a slow decline (Birdlife International, 2011). Therefore, it is classified as near threatened by the IUCN as it is subject to hunting over most of its range in addition to having a moderately small population.

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Satyr tragopan in Bhutan is found mostly in between 1800 and 4500 metre above sea level Inskipp *et al.* (2004). Jigme Dorji National Park (JDNP) is one of the protected areas harbouring several threatened species including Satyr tragopan where approximately 7,000 people reside. Developmental activities for the park residents such as construction of feeder roads, farm roads and electrification are suspected to be causing the habitat disturbances of the birds (Sonam, personal communication, 2012). Fuller and Garson (2000) reaffirmed that developmental activities as contributing factors for the population decline of this species elsewhere. However, in Bhutan, there is a dearth such established facts and information. This poses a serious implication on the conservation status of this near-endangered species in the country.

The objectives of this paper are to determine the habitat use by Satyr tragopan in winter months in the three *Gewogs* (development block or county) and assess threats to its conservation. The study also makes an effort to develop habitat preference map of the species. This will not only help enhance conservation efforts in the park but also help rehabilitating its natural habitat range in the park if damaged.

## Materials and Methods

### *Study area*

The study area was selected in the three Gewogs of Gasa *Dzongkhag* (district) namely Khamoe, Khatoe, and Laya in JDNP as most of the people reside in these Gewogs and many developmental activities are being implemented in these Gewogs (Figure 1). In addition, clearing of forest for installation of power transmission line between Gasa and Laya has already begun which clears about 20 m width along its line leading to removal of substantial area of tree cover.

The study area is located between 28° 14'49.00"N; 89°47'43.94"E in the north, 27° 58'39.41"N; 89°53'50.07"E in the east, 28°

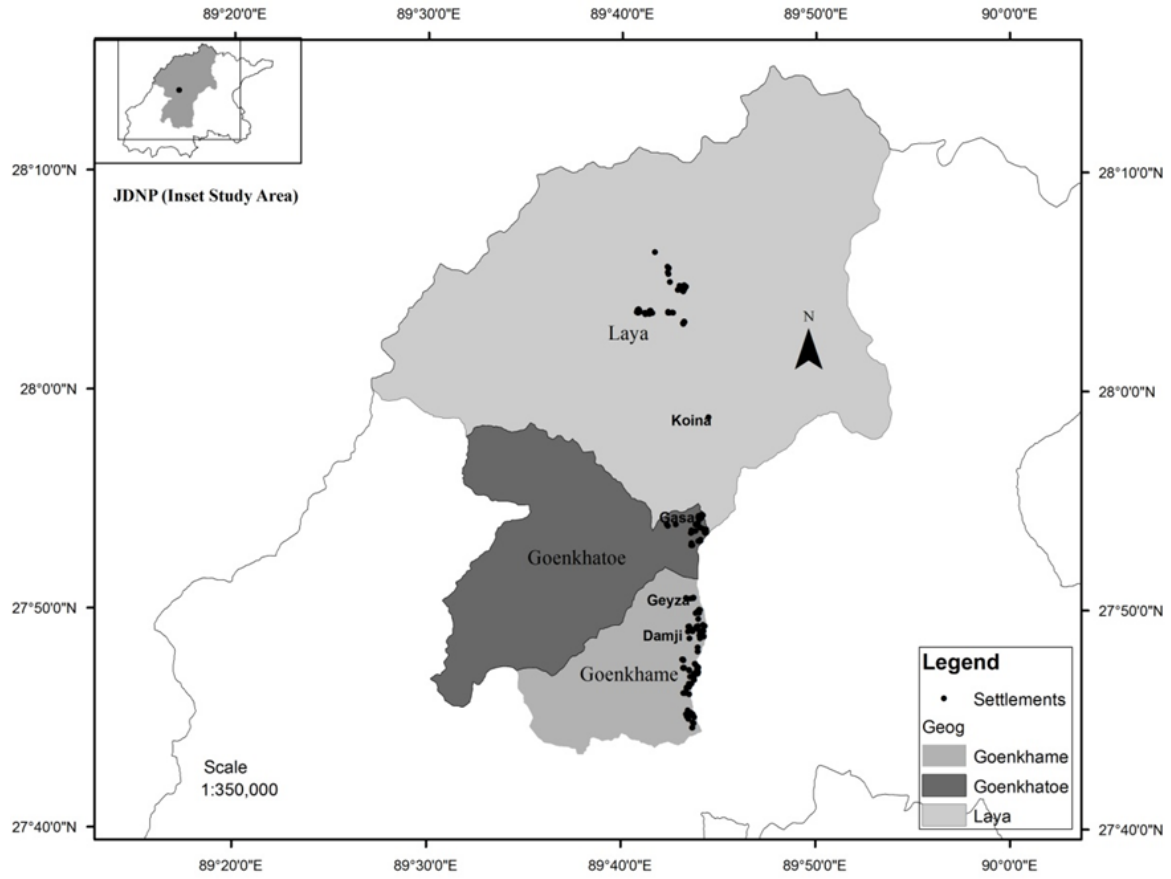


**Figure 1:** Map of study area

0'22.27"N; 89°27'7.54"E in the west and 27° 43'24.09"N; 89°37'49.70"E in the south. The area experiences maximum temperature of 25°C and minimum of -11°C with average monthly relative humidity ranging between 50-92% and annual total rainfall of up to1,971 mm (in 2003). Snowfall is common during winter months (December to February) when the temperature becomes chilly (Thinley *et al*., 2015).

Vegetation types found in JDNP include broadleaved forest, mixed conifer forest, fir forest, juniper forest, shrubs, sub-alpine meadows, and alpine meadows (MoAF, 2011; JDNP, 2011). The altitude of the study area ranges from 1600 to 7000 m above mean sea level. However, actual survey was carried out between 1800-3900 m, which is the winter habitat range for Satyr tragopan which has specific vegetation type such as broadleaved, mixed conifer, fir, juniper, oak, and alder forests. These forests had bamboo under growths in most part.

## Materials and Methods

The study area was stratified into different habitat types based on vegetation types. Line transect of Gibbons and Gregory (2006) and Miller (2010) was adopted for the survey since it was recommended as most appropriate for the bird survey. A total of sixty transects with 1 km length were identified and used for data collection. During the survey, whenever Satyr tragopans were sighted, flock size and composition were recorded in the data sheet irrespective of distance of sighting from the transect line. A circular plot of 12.62 m radius was laid at each sighting site to collect data on vegetation composition, crown and circular plot of 5.64 m radius was used to record shrub cover. Such plots are used for ecological monitoring and for vegetation sampling to study habitat preference (Simon *et al*., 2016). Variables such as elevation, aspect and slope, and signs of any disturbance were recorded to study habitat condition and variables such as species list, canopy cover, shrub cover, tree girth and shrub height were measure to study species composition and diversity where the tragopans were sighted. During the entire survey, 34 sightings were made. In addition, 40 sightings were made in the earlier field visits by Dorji (personal communication, 2011). These data were analysed using statistical package for social science version 16 (SPSS) to test associations between tragopan occurrence and habitat types, aspects, slopes and elevation.

*Habitat mapping*

For the spatial mapping of habitats of tragopan, habitat types were extracted from the land cover assessment map 2010 (MoAF, 2011) using ESRI ArcGIS 9.3. This would provide types of vegetation covers that are preferred by the birds. According to Ramesh *et al*. (1999) and Inskipp *et al*. (2004), topographic factors were also found to influence habitat preferences, in that the birds were found mostly between slopes of 0 ° and 45 °, aspects of east and southeast, and elevation of 1800 and 4500 m. As such, all these ranges of slopes, aspects and elevations were extracted for analysis. The analysis was carried out using the Weighted Overlay function of the ArcGIS tool called Spatial Analyst Tools. Essentially, the method provides analysts to score/weight the variables according to their importance as habitat factors. Scoring was done based on the frequencies of sighting- higher the frequencies, higher the scores and vice versa. The outcome of analysis is a probability map of habitat suitability ranging from low to high suitability.

## Results and Discussion

*Habitat type and preference*

Satyr tragopans preferred oak forests in the winter months and moved according to food availability and snowfall ($r = .504, p < .017$). Frequency of Satyr tragopan occurrence was maximum ($M = 1.6, SE \pm 0.21$) in the oak forest, followed by fir forest ($M = 1.34, SE \pm 0.28$), alder ($M = 1.14, SE \pm 0.13$) and juniper ($M = 1.14, SE \pm 0.10$). Norbu *et al.* (2013) also reported similar results, where they found that

migratory and resident tragopans utilized a range of forest types, with migratory individuals preferring cool broadleaved forests during winter. Hei-Tao and Guang-Mei (2006) also supported the results, that Temminck's tragopan (*Tragopan temminckii* Gray) moved to broadleaved-bamboo mixed forest and usually occurred in a variety of broadleaved-bamboo mixed forests in winter. Likewise, Kamal and John (1986) made 54% of the sightings of western tragopan (*Tragopan melanocephalus* Gray) in oak plant association at Macharia in northeastern Pakistan.

*Slope*

All the Satyr tragopans were sighted below 40° slope. Kendall's tau test between slope and Satyr tragopan numbers showed no significant correlation ($r$ = .2, $p$ > 0.05). This shows that slope does not affect occurrence of Satyr tragopan distribution in its winter habitats. However, Ramesh (2003) found Himalayan monal (*Lophophorus impejanus* Latham), koklass (*Pucrasia macrolopha* Lesson) and western tragopan (*Tragopan melanocephalus*) in gentle (24°) to moderate slopes (45°) in summer season and in slightly steeper slopes (> 45°) in winter in the Great Himalayan National Park.

*Aspect and elevation*

Satyr tragopans were mostly sighted in the east and southeast aspects ($p$ < .05) indicating as preferred habitat of the birds (Figure 2). Norbu *et al.* (2013) also reported that the migrants occupied southeast facing slopes during winter, whereas resident Satyr tragopan remained on south-west facing slopes. This is probably because east and southeast aspects are warmer than other aspects making environment conducive for their survival during the cold winter months. A similar result was found for the brown-eared pheasant (*Crossoptilon mantchuricun* Swinhoe) and common pheasant (*Phasianus colchicus* Linnaeus) which selected partially sunny slope in winter (Li *et al.*, 2009). In 2003, Ramesh found that Himalayan monal (*Lophophorus impejanus*), koklass pheasant (*Pucrasia macrolopha* Lesson) and western tragopan preferred south and east facing aspects in summer season while distributions were skewed towards south and southeast facing aspects in winter. However, there was no association between elevation and tragopan ($r$ = .123, $p$ > .05), although the latter was mostly recorded between an elevation of 2300-3900 m.

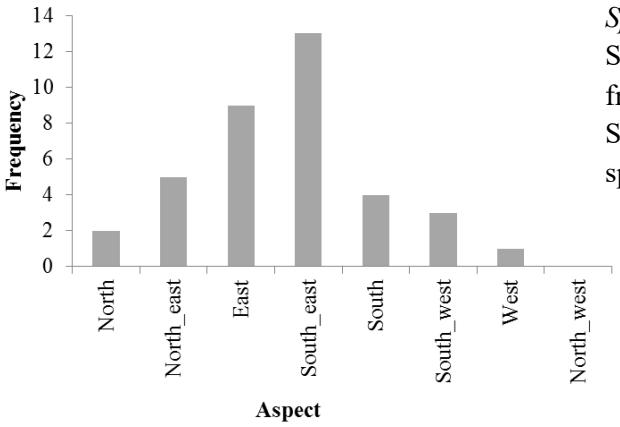


**Figure 2.** Frequency of Tragopan sighting in each aspect

*Crown cover and shrub cover*

The canopy cover was between 0% and 90% ($N$ = 34) with a mean of 60.29 ± 30.77 *SD* in the areas with Satyr tragopan sighting. Kendall's correlation showed no association between canopy cover and bird count ($r$ = .18, $p$ >.05) which means that the bird distribution is not dependent on canopy cover (Table 1). Shrub cover in the areas with tragpoan was found to be between 10% and 80% with a mean of 51.18 ± 27.39 *SD* (Table 1). Similarly, there was no association between shrub cover and bird count ($r$ = .16, $p$

*Species diversity of plants and Satyr tragopan*

Shannon-Wiener Index (H') of plants ranged from 0.00 to 1.95 with a mean of 1.250 ± 0.600 SD ($N$=34). About 13 species of trees and 16 species of shrubs were recorded in the sample plots. Dominant tree species recorded were oak (*Ouercus semecarpifolia*), juniper (*Juniperus recurva*), birch (*Betula utilis*), alder (*Alnus nepalensis*), Himalayan yew (*Taxus wallichiana*), rhododendron (*Rhododendron arboreum*), *viburnum* sp., etc. and while shrubs are daphne (*Daphne bholua*), barberry (*Berberis*

**Table 1.** Association between Satyr tragopan number, elevation, canopy, and shrub covers

| | Tragopan No. | Elevation | Canopy cover | Shrub cover |
|---|---|---|---|---|
| Satyr tragopan No. | 1 | 0.123 | 0.092 | 0.055 |
| Elevation | 74 | 1 | 0.008 | O.308 |
| Canopy cover (%) | 34 | 24 | 1 | 0.026 |
| Shrub cover (%) | 34 | 24 | 34 | 1 |

*Significant at p > .05*

*aristata*), *Sarcaccoca saligna*, *Smilex* sp. However, there was no association between plant species diversity and tragopan number ($r$ = .16, $p$ > .05) and Satyr tragopan did not show any preference of vegetation type. Similar result was also found in case of Western tragopan which selected shorter life-forms (shrub, short deciduous and short coniferous forest) and avoided taller vegetation at both study areas (Kamal and John, 1986) although Tao and Mei (1996) found that Temminck's tragopan which moved to the broadleaf-bamboo mixed forest often lived in the areas rich in fruits of *Alangium chinense* and *Macrocarpium chinensis* in winter.

*Threats*

About 54.72% of the survey plots ($N$ = 34) had presence of threats such as trapping, tree felling, power transmission line, grazing, and road construction. Among these threats, tree felling was the most prominent threat followed by bird trappings which is associated with tree felling activity (Figure 3). Where presence of tree felling is more (68%) than the absence (32%), there was significant association between tree felling and trapping ($r$ = .38, $p$> .05) which means that poaching is mainly done by people who cut timber and firewood. Presence and absence of trapping signs were found almost equally in the 38 sample plots whereas the presence of transmission line, road, and grazing were significantly lower ($r$ = .531, $p$ <.05). Therefore, tree felling is the single most threat to Satyr tragopan in the study area. Similarly, grazing and tree lopping were the main threats to Satyr tragopans in Singhalila National Park in India (Khaling *et al*., 1998). In the temperate forest of Western Himalaya in India, numbers of Koklass pheasants, Himalayan monal, Cheer pheasant, and Western tragopan declined significantly with anthropogenic activities (Pandit and Jolli, 2012). Poaching and habitat degradation are the main threats to galliforme species and their habitats in Khangchendzonga Biosphere Reserve in India (Sathyakumar *et al*., 2010). Jolli and Pandit (2011) also cited that large scale development can lead to decline of Himalayan pheasant in Himalayan region due to their response to

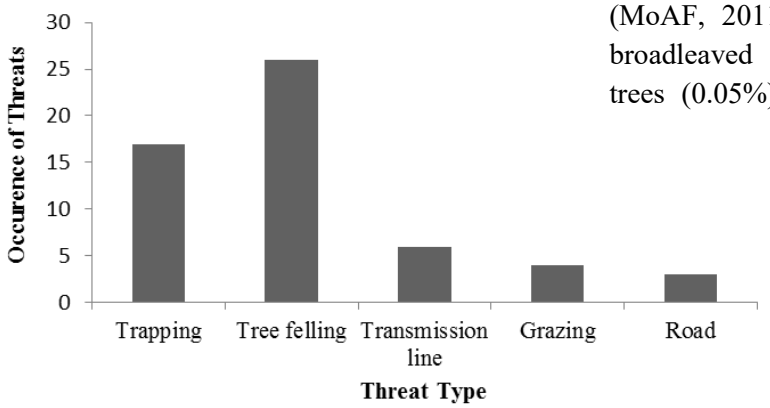


**Figure 3.** Threats in the study area

*Habitat mapping*

Vegetation coverage of JDNP is approximately 2,879.86 km$^2$, which is about 67% of the park (MoAF, 2011). The vegetation comprised of broadleaved (13%), broadleaved with conifer trees (0.05%), blue pine (0.15%), fir (16%), mixed conifer (23%), alpine meadow (12%) and shrubs (37%) as per the land use data (Table 2).

**Table 2.** Vegetation coverage of JDNP

| Vegetation types | Area (km$^2$) | % of total veg. coverage | % of the park |
|---|---|---|---|
| Broadleaved, FB | 361.81 | 12.56 | 8.37 |
| Broadleaved with conifer trees, FBc | 1.58 | 0.05 | 0.04 |
| Blue pine, FCb | 4.18 | 0.15 | 0.1 |
| Chirpine, FCc | 0.09 | 0 | 0 |
| Fir, FCf | 463.87 | 16.11 | 10.73 |
| Mixed conifer, FCm | 648.21 | 22.51 | 15 |
| Alpine meadow, GP | 348.05 | 12.09 | 8.05 |
| Shrub, SH | 1,052.07 | 36.53 | 24.34 |

Habitat suitability mapping was done using weighted overlay. All parameters such as habitat types, slope, aspect, and elevation after rasterising were overlayed (superimposed) in ArcGIS 9.3 because the weighted overlay table allows calculation of a multiple criteria analysis between several rasters. Each parameter was given different scores corresponding to the preference shown by tragopan. The weighted sum showed that an area of approximately 24% (1,018.81 km$^2$) of JDNP is suitable for Satyr tragopan in winter. The most suitable habitat is approximately 398.10 km$^2$, moderately suitable habitat is 608.97 km$^2$, and least suitable habitat is11.74 km$^2$ (Figure 4).

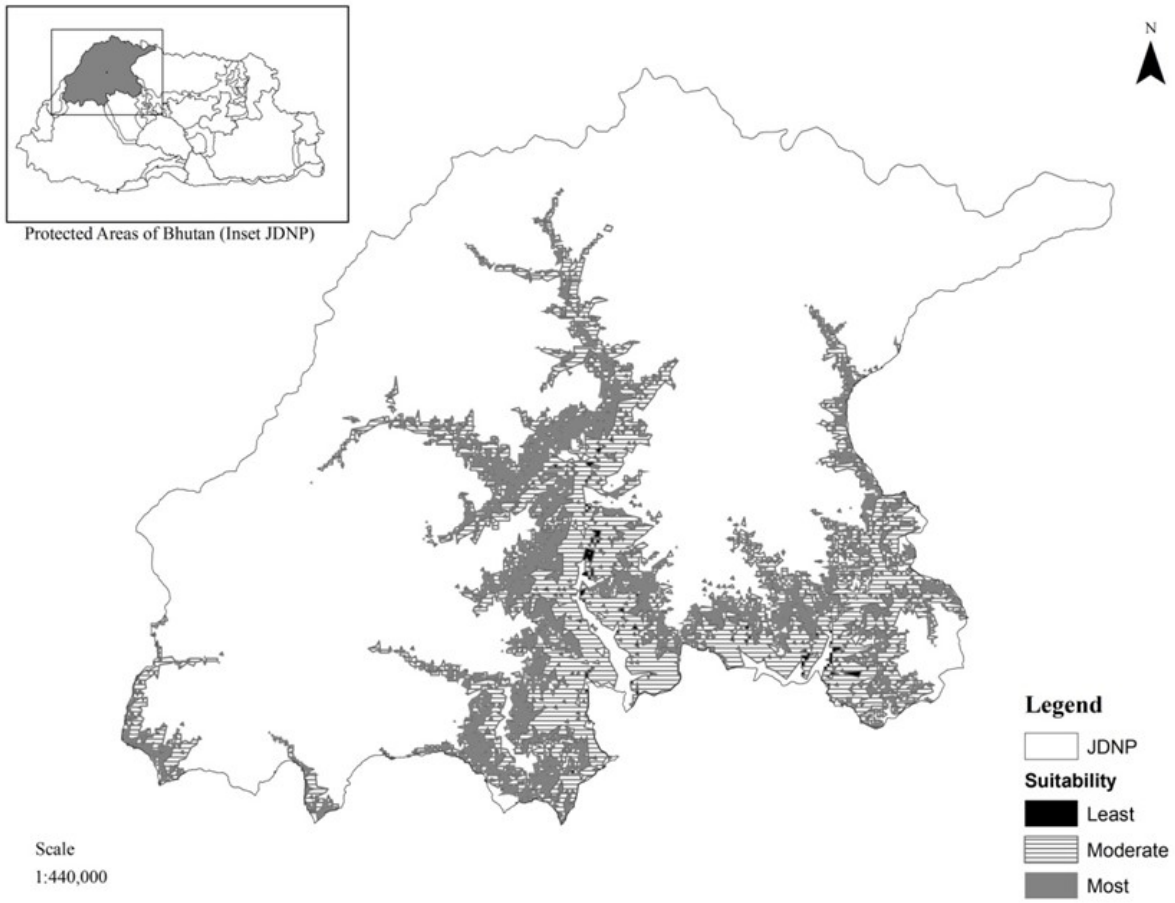


**Figure 4.** Habitat suitability for Satyr tragopan in winter in JDNP

## Conclusion

Habitat preference of *Satyr tragopan* in JDNP was assessed using transect lines and sampling plots. During winter, migrant Satyr tragopans occupied southeast facing slopes preferring cool broadleaved forests, mostly in the oak forests although they are also found in alder and juniper forests. Slope (0° to 40°) and elevation (2300-3900 m) had no association with the distribution of Satyr tragopans in their winter range. Similarly, canopy cover, plant diversity, and shrub cover did not influence the abundance and distribution of Satyr tragopan. One of the important threats is tree felling (62%) followed by poaching or hunting, yet approximately 24% of the park is suitable habitat for Satyr tragopan. However, the Satyr tragopan confined mostly to oak and juniper forest with bamboo thickets. Therefore, conservation and management of oak and juniper forests as winter habitats of Satyr tragopan is important. Further studies are required to cover wider area of the park for effective conservation of this species. In addition, strategic planning and regulation is required during implementation of forestry activities based on the habitat preferences of the birds as indicated in the results. Regular patrolling in the areas of highly suitable habitats may also aid in reducing poaching.

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