A PRELIMINARY HABITAT SUITABILITY MODEL FOR THE SNOW LEOPARD, Panthera uncia, IN WEST NEPAL

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I. INTRODUCTION

We have developed a simplistic model to predict habitat suitability for snow leopard *(Panthera uncia)* in the western Himalaya of Nepal. Habitat relationships used in this model are based on an in depth, 3-year investigation of snow leopard ecology currently being undertaken in the Langu Valley, west Nepal.

Virtually no information is available on the status, distribution and ecology of snow leopard in its native environment (Schaller 1977). As populations of this endangered species continue to decline, there is an urgent need to determine the current status and distribution of snow leopards throughout their range in order to: I) identify areas where populations persist, and 2) determine the suitability of specific areas for protection and management. It is, however, very difficult to determine abundance, indeed even presence or absence, by direct census techniques because snow leopards inhabit remote, rugged mountainous habitat, occur in low numbers and are sparsely distributed. The model described in this paper provides a tool for assessing the quality of existing habitat conditions of a given area to support snow leopard, in relation to assumed optimum conditions. When used in conjunction with a validation survey (which involves a ground search for sign), crude estimates of abundance can be made to support conclusions about the status of the cat in the survey area.

Integration of wildlife habitat concerns with multiple resource planning and management must consider ecological relationships, public sentiment, economics and *other* societal needs.

During the 1970's, analytical models were employed to approach the increasingly complex and difficult task of providing resource decision-makers with consistent, reliable information concerning the existing biological capability of given habitats and the consequences of manipulation (Nelson and Salwasser 1982, Thomas 1979, USFWS 1980). Karpus (1975) described the evolution of modeling as a progression through the following stages:

1) The scientific discipline develops a quantitative orientation.
2) A group begins to develop mathematical models.
3) Modeling and simulation of systems becomes a formalized activity within the field.

Conceptually, species-habitat relationship models assess biological resource values directly from habitat quality and quantity attributes and their known or implied capability to satisfy the life requirements of a species. The greater the capacity of a given habitat to provide sufficient life needs (e.g. food, cover, water, space, protection, etc.) in the appropriate spatial and temporal arrangements, the greater is its value to the species.

Existing information of a species ecology and habitat requirements are used to identify, arrange and aggregate predictive habitat variables (i.e., measureable physical, chemical or biological factors) to construct a species optimization model. These models are essentially explicit descriptions of optimum habitat conditions for a species.

We clearly recognize that the model presented in this paper is simplistic, as the ecological information presently available on snow leopards and their ungulate prey species is sparse: thus, its predictive capability should be viewed with a certain amount of caution. However, the development of a simplified model is the first step in the modeling process, and must be followed by data collection and analysis. model redesign, and mode] validation (Holcomb Research Institute 1976). Models continually evolve and their predictive resolution increases with application, monitoring and new knowledge. When working with natural ecosystems, it is best acknowledged that ". . . uncertainty is a fundamental facet of environmental life rather then. . . a distasteful transition to attainable certainty." (Holling 1978: 139).

Our primary objectives in presenting this paper are: I) to present a predictive model for evaluation of snow leopard habitat; and 2) to promote the concept of modeling as a valid means of improving our knowledge of .snow leopard ecology and the ecosystems they inhabi t, and as a tool to enhance communication and education between researchers, resource planners and managers, decision makers and society.

SNOW LEOPARD LIFE REQUIREMENTS: AN OVERVIEW

Snow leopards inhabit the mountains of Tibet, the Himalaya of Bhutan, Sikkim, Nepal, India, the Karakorum and Hindu Kush of Pakistan, and into Afghanistan. Beyond the Himalayan region, the range extends over the Pamir, Tien Shan and Altai Ranges to the Sayan Mountains near Lake Baikal along the border of the Soviet Union and the People's Republic of China. To the east, populations occur along the edge of the Tibetan Plateau as far north as Chinghai Province in China (IUNC 1978, Schaller 1977). Total historic range is in excess of 2.5 million square kilometers. Uncommon to rare throughout most of its range, the remaining populations of snow leopards occur in montane environments sparsely inhabited or minimally disturbed by man. The historic populations occupying the wetter, southern slopes of the main Himalayan range have been severely decimated. In the Himalaya, snow leopard occur primarily in the "inner" ranges in areas of relatively low precipitation up to an elevation of about 5,600 m., and most commonly between 3,000 and 5,000 m. Typical habitat through much of the Himalaya appears to be above the treeline in broken, rocky, sparsely vegetated and dry alpine steppe. In Pakistan, they may descend as low as 1,500 m. during winter to oak scrub or open spruce forest (Roberts 1977).

Food Requirements

Ibex *(Capra ibex),* bharal or blue sheep *(Pseudois nayaur),* and possibly Himalayan tahr *(Hemitragus jemlahicus),* are the main prey of snow leopard in the Himalaya (Jackson 1979a, Roberts 1977, Schaller 1977), although livestock (especially sheep & goats) are important food items in areas depleted of native prey. Other prey reported includes takin *(Budorcas taxicolor),* goral *(Nemorhaedus goral),* serow *(Capricornis sumatraensis),* markhor *(Capra falconeri),* urial *(Ovis orientalis),* argali *(Ovis ammon),* musk deer *(Moschus chrysogaster),* hares *(Lepus spp.),* marmot *(Marmota spp.),* monal pheasant *Lophophorus impejanus),* chukor *(Alectoris chukar),* and snowcock *(Tetraogallus spp.)* (Dang 1967, Guggisberg 1967, Roberts 1977, Schaller 1977, Ward 1923). Most wild high altitude ungulates except adul t kiang *(Equus kiang),* takin, and yak *(Bus grunniens),* are potential prey. An optimum predator-prey ratio is judged to be in excess of 1 :200 on a weight basis, while predator utilization of the prey does not exceed 10 % of the standing crop (Schaller 1972, Sunquist 1981). Based on captive cats, the food requirements of an adult snow leopard are estimated at 1.3-2.0 kg. per day. This amounts to 600--900 kg. of meat per annum, a figure that accounts for inedible portions (estimated at about 35 %), and increased energy expenditures incurred by free-roaming cats (estimated at 25 %). A female with dependent cubs would require correspondingly more.

Snow leopards appear to kill more adult males than females (Schaller 1977, this study.) In estimating prey requirements in the wild, we have assumed kill proportions of 60 % adult male, 15 % adult female, 10 % lambs and 15% yearlings. A population of 150 230 bharal would be required to support one adult snow leopard in the Langu Valley, given the present bharal age and sex composition (38 % adult males; 31 % adult females; 15 % yearlings and 16 % lambs) and an overall harvesting rate of about 13 % of the standing crop. An adult cali is assumed to require 20 -30 bharal annually.

Cover **Requirements**

Snow leopards are partial to terrain broken b cliffs, rocky ridges, gullys and ravines which provide important bedding, escape, repro ductive, thermal and hunting cover (this study)

These areas usually are moderately to very steep *(>40-50°* slopes) with sparse vegetation cover. Our preliminary findings indicate that specific topographic features and landform categories are preferred for certain cover requirements. Broken cliffs and steep rock outcrops are used most frequently for bedding, hiding, escape, denning, and presumably thermal protection. Leopards characteristically travel along ridgelines, the crest of cliffs and river bluffs, theoretically increasing the potential for detecting, stalking and killing prey. Terrain structurally broken by small rock outcrops, ridges and gullys provides the cat with cover necessary to stalk its prey. In alpine grassland and even terrain, shallow gullys appear to be used while hunting.

As human encroachment into snow leopard habitat increases, the value of secure escape, denning and hiding cover which offers concealment from humans also increases. In areas of high winter precipitation, south-facing slopes and steep areas that shed snow are probably importan t to snow leopard as well as its prey.

Reproductive Requirements

Secluded rocky areas with a readily available food supply are critical during the first few months after birth of the cubs. Both adult males and females are solitary. Duration of estrus in the wild is unknown. In captivity, sexual maturity is usually reached at about 3-6 years in both males and females (mean = 3.9 years for females) (Blomqvist & Sten 1982). The sexes associate briefly during the mating season (January - March). Most births probably occur during late spring and early summer (late May - July) (Roberts 1977, Schaller 1977, this study).

Litter size (in captive cats) varies from 1--5 and the few records from the wild indicate litters of 2 or 3 in the Himalaya (Schaller 1977) and up to 5 in the Soviet Union (Heptner and Sludskij *1980).* Cubs venture from the den at 5-6 weeks, and consume small quantities of meat when 6-8 weeks old. The survival rate is unknown.

Interspersion

Snow leopards are crepuscular, but may be active ,day or night. They often hunt during daytime, especially *where* undisturbed (this study). Snow leopards are reported to migrate seasonally with their prey (Guggisberg 1975, Novikov 1956), but this has not been substantiated in the Langu VaHey (this study). Presumably seasonal movements of prey occur only in areas with heavy snowfalls, areas with limi ted southerly and westerly exposures, and locales subject to seasonal disturbance by man.

Home range size (minimum area) for five individuals (3 males; 2 females) in the Langu Gorge ranges from 9 to 20 km2 , a figure that fails to account for the considerable topographic relief. Adult males apparently occupy larger ranges than adult females. The Langu home ranges are 3 times as long as wide, measuring about 7.5 by 2.5 km. Individuals usually visit both ends of their range in a two week period, and all cats had certain areas which they preferred *over* others. In the Langu Gorge, the mean minimum daily (straight line) distance moved by five individuals ranged from 0.6 to 2.0 km.

Densities have been crudely estimated at about 0.15/100 km2 in Chitral, Pakistan (Schaller 1976) and 5.8/1 00 km 2 and 8.3/1 00 km2 for two valleys in Ladakh (Osborne, pers. com., cited in Green 1982). The Langu population is estimated at more than 6 animals/l 00 km2 (this study). Schaller (1977) reported that at least 6 snow leopards inhabited an area of 500 km2 (a density of about 1.2/100 km2) ill the Kanjiroba Range southeast of the Langu.

Special Considerations

Isolating Factors

The size, location and degree of buffering of the core area under consideration is important in terms of snow leopard population ecology and conservation.

Soule and Wilcox *(1980)* postulate that at least 50 breeding pairs are required to minimize the likelihood of detrimental genetic inbreeding.

Few, if any, isolated 500 km 2 areas are likely to support this number of cats; therefore the presence of corridors linking separate areas becomes a critical consideration. Corridors of at least marginal habitat permi t emigration and immigration, thereby facilitating genetic interchanges. Adjacent, sparsely inhabited or protected areas, particularly national parks and wildlife reserves, can act as reservoirs to repopulate depleted areas.

TABLE 1: RATING OF HABITAT VARIABLES FOR SNOW LEOPARDS

Species [1]	Cover Type [2]	Variable Measured	Habitat Suitability Rating: Suitable High	Medium	Marginal Low
Food					
B	G,S	Canopy Cover	>3O%	>10 to <30%	<10%
B	S	Composi tiDn Grass/F orbs	>2S%	>10 to 2S%	<10%
B	F	Composi tion Grass/Forbs	-	>2S%	<2S%
B	G,S,F	Average Aspect [3]	160-200	130 to <160 or >200 to 2300	<130 or >2300
B	G,S,F	Average Slope	<300	30 to 400	>400
Cover					
B	G, S, F , Ba	Average Slope	>30	20 to <30	<20
B,SL	G,S,F,Ba	Average Aspect	160 to 200	130 to <160 or >200 to 2300	<130 or >2300
SL	G, 5, F ,Ba	Average Slope	>40	3S to <40	<3S
Interspersion					
B	G,S,F ,Ba	Distance to Forage-Cover Edge	<200 m	>200 to 400 m	>400 m
a	G,S,F ,Ba	% Foraging Habi tat	>75 to 85%	>50 to <75%	<50% or >85%
		% Cover Habitat	>15 to 25%	>25 to <50%	>50% or <15%
SL	G, S, F ,Sa	Distance to Feeding-Cover Edge	<o.S km	>0.5 to 1.0 km	>1.0
SL	G,S,F ,Ba	% Cover Habitat	>25%	>lS to <2S%	<15%

1/ B " bhara I; SL " snow leopard

2/ G " grassland; S " shrubland; F " forest «20% tree canopy cover)

Ba " barren «10% plant cover) -

3/ Where 0 is true North

Human Disturbance and Land Use **Factors**

The serious population decline of snow leopard has been attributed to strong hunting traditions within its range, demand for its fur, depletion of prey species and predation upon livestock leading to persecution by livestock owners (IUCN 1978,Jackson 1979b).

Although settlements are a fact of life in the Himalaya, human activities are of critical importance to a rare and shy predator such as the snow leopard. Cat populations may be impacted directly by killing for pelts or in an attempt to control real or imagined livestock depredation. Uncontrolled hunting has decimated prey populations, thus indirectly affecting snow leopards. Even if hunting is not pervasive, livestock may remove much of the forage available to prey species. Human population density, per se, provides only a rough approximation of an area's suitability to support snow leopard; from a conservation viewpoint the land uses practiced and local attitudes or customs are paramount. land use may be easier to change or regulate than traditional customs, such as the human intoler. ance of predators.

The densest populations of snow leopards occur in areas where the density of human settlements is less than I per 100 km2, for example, parts of Dolpo, Mugu and Humla Districts in west Nepal.

TABLE 2: RATING OF OTHER VARIABLES FOR SNOW LEOPARDS"

FACTOR	VARIABLES MEASURED	HABITAT SUITABILITY RATING SUIT ABLE	MARGINAL
Isolation of	Physical or	Isolating Factors	I so lating Factors
Sub-popu lations	Ecological Barriers	Insignificant	Significant
Human			
Set t lements	Pattern	Few Clustered	Many Scattered
Li vestock	Rangeland		
Grazing	Condition	Proper Use	Overuse
Li vestock	Li vestock		
Depredation	Losses	Insignificant	Significant
Hunting	Hunting of Snow		
	Leopard and Prey	Insignificant	Significant

"See text for explanation of factors

III. HABITAT SUITABILITY MODEL

A. Model Applicability

Geographic Area
The model is applicable to the Himalaya of west Nepal (810 840 East) at elevations exceeding 3,000 m. with an annual precipitation of less than 500 - 1,500 mm.

Season: The model is designed to evaluate winter habitat suitability for the major prey species, the bharal. Food requirements of bharal are assumed to be particularly critical during harsh winters with deep snow and cold temperatures. Basic snow leopard habitat relationships and requirements are assumed to be similar throughout the year.

Cover Types: The model evaluates grassland, shrubland and barren (less than 10 % vegetative cover) cover types. Extensive areas of dense (>20 % tree canopy cover) forest is assumed to be unsuitable for both snow leopard and bharal.

Minimum Habitat Area: Minimum habitat area is defined as the minimum amount of contiguous habitat that is needed to support a reproductive pair of snow leopards. It is assumed, to be the average male home range size - 14 km2 (this study). The minimum area required for the maintenance of genetic fitness and adaptive potential is unknown. However, since at least 50 breeding adults are needed to keep inbreeding at less than I %, the total area evaluated should encompass at least 500 contiguous square kilometers, unless substantial potential exist for successful immigration and emigration.

Other Considerations: The model is applicable to areas having a crude permanent human settlement density of less than 10-15 villages/ 100 km2.

B. Model Variables

The model considers food and cover as primary snow leopard life requirements. Leopard food requirements are evaluated by considering the availability of its principal primary prey (i.e., bharal in this case) (Jackson 1979a, Schaller 1977), which is assessed by the quality of bharallife requirements (i.e., food and cover) in each cover type as well as the interspersion of each type. The quality of snow leopard life requirements in each cover type and the interspersion of each are used to derive a total area suitability. Figure I shows how winter life requirements, cover types and model variables are related. Table 1 indicates how each habitat variable is rated, according to three categories of suitability. Human disturbance, land use and isolation factors are incorporated as modifers of the total area suitability (Table 2).

A procedure for arriving at a final habitat suitability rating will be presented following testing of the model. Until then, we treat all variables equally. Refinement of the model demands the ranking and aggregation of variables. We will address habitat variable sampling methodology and design as well as techniques for model validation later.

Food

I) *Snow Leopard*

Food suitability for the snow leopard is related to the availability of primary prey. Thus, the model focuses on habitat suitability for bharal, but assumes that adequate supplemental medium and small sized prey are available in optimum bharal areas. We further assume that bharal abundance is directly related to the quality and interspersion of forage and cover.

Prey detectability and accessibility is assumed to be related to the quantity and interspersion of vegetation in moderately broken terrain, which provides hunting cover for snow leo pards. Those areas may also provide some bharal food and cover. Food, cover and interspersion components for bharal are evaluated separately, then combined to yield food suitability for snow leopard.

2) *Bharal*

Prey populations are ultimately controlled by forage quality, quantity and availability. Bharal are primarily grazers, preferring various grasses and forbs throughout the year (Schaller 1977, Wegge 1976, Wilson \98\). Shrubs may provide an essen tial food source in areas heavily grazed by livestock (Schaller 1977) and during winter (Roberts 1977, Wegge 1976) when accumulation of snow precludes or limits the consumption of herbaceous vegetation. Snow cover reduces forage availability, impedes movement, mobility and habitat selection, increases energy expenditures, and may cause crowding and the subsequent overuse of critical winter ranges. The generally warmer tem peratures and increased solar radiation of southerly slopes reduce heat losses and increase snowmelt, thereby minimizing thermoregulatory st resses and maximizing access to forage. In winter and early spring, bharal foraging areas are generally restricted to southern exposures with gradual to moderately steep slopes (<3) degrees) (Wegge 1976, Wi]son 1981). Bharal tend to utilize the middle slopes of mountain ranges, thus avoiding exposures to colder temperatures that prevail at higher elevations or ridgetops and in valley bottoms (Schaller 1977, Wegge 1976, Wilson 1981, this study).

Wegge (1979) found that while larger herds and the greatest number of individuals foraged in uniform terrain with gradual slopes «200), smaller herds generally were restricted to moderately broken (i.e., structurally diverse) steeper «350) terrain. He concluded that this was due to the selective pressure of predation and the adaptive characteristics of social behavior (Estes 1974, Geist 1974, Jarman 1974).

It is assumed that while steeper broken terrain may be less productive bharal habitat, these areas are important to the overall maintenance and distribution of prey populations, especially during winter.

Optimum winter bharal foraging areas consist of grasslands with >30 % canopy cover, shrubland with >30 % canopy cover and >25 % composition of grasses and forbs, with south erly exposures (average aspect from 1600 to 200°), generally uniform terrain, and an average slope <300.

Cover

1) *Bharal*

Escape, resting, bedding and thermal cover is critical for maintaining prey populations. Bharal rely almost exclusively on steep, broken, rocky terrain as cover to bed, to lamb, to escape predators, and to help maintain homiothermy (Schaller 1977, Wegge 1976, Wilson 1981).

Steep, broken rocky terrain with southern exposures provide cover and limited forage during periods of continued snowfall: less snow accumulates 0n precipitous or steep (>35°) slopes. The increased structural diversity provided by broken rocky areas also tends to mitigate for the effects of extremes in ambient air temperature, thermal and solar radiation and wind speed.

Optimum winter cover for bharal is provided by rocky terrain broken by gullys, scree chutes, ravines, ridges and scattered promontories, with average slopes between >300 and average aspect between 1600 to 2000.

2) *Snow Leopard*

Suitable winter *cover* is a function of the quantity, aspect and interspersion of precipitous, broken terrain. These areas presumably provide leopard with escape, hunting, thermal, bedding and reproductive cover. It is assumed that *cover* requirements for snow leopards are satisfied if winter bharal *cover* needs are met. Terrain providing *cover* for bharal is probably used by cats most frequently for resting, hunting and travelling. In the Langu Gorge (this study), it was found that leopards use cliffs with ledges to a much greater extent than their availability in the study area. Thus, optimum winter snow leopard *cover* consists of cliffs with rocky or brushy ledges, average slopes of >40°, with an average aspect between 160° to 2000.

Habitat Interspersion I)
Bharal

It is assumed that the availability of food and *cover* to bharal is a function of the abundance and interspersion of both life requirements. Since food and *cover* are provided by different habitats, and both requirements must be present to support sheep, we have assumed that "effective interspersion" can be estimated by considering the distance between each habitat. Effective interspersion is a measure of the amount of usable area providing each life requirement (Odum 1971).

Scant data is available to assess bharal interspersion relationships. However, basic conclusions from several studies (Schaller 1977, Wegge 1976 and 1979, Wilson 1981) and systematic observations of prey occurrence and relative abundance in relation to vegetation and topography (this study) indicate that bharal movements are characteristically restricted to small areas and that both food and *cover* are obtained within a short distance of the forage*cover* interface. (Wegge 1976: 20) noted that "extensive grassy meadows which at first may look like prime sheep ranges, receive little use as the animals are reluctant to move further than I 00-150 yards away from rocky outcrops or steep bluffs." Movements by bharal in winter are typically restricted to less than 1 km. (Schaller 1977, Wegge 1976). Bharal forage in moderately xeric vegetation communities with relatively low productivities. During winter, forage production for a given area decreases while metabolic demands increase.

The model assumes that high and medium forage areas must occur within 200 m. of *cover* and, conversely, that optimum *cover* areas are within 200 m. of forage areas. It is also assumed that the best bharal habitat contains high quality food over 75 to 85 percent of the area.

2) *Snow Leopard*

A mixture of food and *cover* areas in close proximity provide predators with a greater opportunity to select the most favorable can. ditions at any given time, whiie minimizing energy expenditures due to travel between resting and feeding sites. It is assumed that; the amount of usable area providing *cover* and t food requirements for snow leopards can be estimated by measuring the distance between' each habitat.

To meet optimal *cover* requirements of snow leopard, we assume that high and medium hunting, feeding and *cover* areas occur within 0.5 km. of each *other,* and furthermore, that *cover* totals about 25 % of the area and is patchily distributed.

Special Considerations

Isolation of Sub-populations

Geographically isolated areas have a low potential to support snow leopard in the long. term. Isolating barriers, such as major rivers, broad alluvial valleys, extensive montane plateaus, and wide belts of dense, continuous forest impede or preclude movements of individuals, increase the likelihood of local populations being hunted out, and promote genetic inbreeding. In *order* to minimize the need for artificial management of the gene pool and to maximize genetic fitness of the species, conservation efforts should be concentrated in those areas contiguous with the snow leopard's core range.

A marginal rating is given when the area surveyed consists of small islands of favorable: habitat surrounded by extensive unsuitable: terrain. The optimal situation exist when the survey area is contiguous or virtually cono tiguous with favorable habitat, and few or no barriers exist to free movement and habitat selection by snow leopard.

Density and Pattern of Human Settlements

The model assumes optimal conditions exist in areas with few villages «5 permanent settlements per 500 km2), in areas with a clustered settlement pattern, and in areas where the sphere of human disturbance is limited to a minor portion of the 500 km2 evaluation area. Rating decisions are necessarily rather subjective, but the ideal situation is a few villages situated close to one another. Critical elements in terms of wildlife are the extent of livestock grazing, livestock losses due to predation, and hunting of wildlife. More emphasis should therefore be placed on an evaluation of existing land uses.

Optimal habitat occurs in areas with trade and small cottage industry as the primary livelihoods. Intensive grazing and overutilization of rangeland, if present, occurs only at lower elevations, is localized to small areas or to the immediate vicinity of settlements. High elevation grasslands receive no or very light livesstock use, and burning, if present, is ecologically compatible with the maintenance of rangeland productivity. Furthermore, existing or potential livestock depredation by snow leopard is insignificant. Since villagers may travel up to 15 km. to grazing grounds, the evaluation must encompass known livestock grazing patterns in the area with particular emphasis on ecologically sensitive habitats and areas. Even if few villages are present in the area, seasonal migration from surrounding areas may be significant. Therefore, it is recommended that direct and indirect land uses in a 15 km. wide buffer strip circumscribing the 500 km2 area be included in the assessment.

Marginal suitability areas are characterized by widespread overgrazing by livestock, persistent use of high alpine pastures, frequent burning of rangeland and significant losses of livestock due to snow leopard predation. The key to determining the impact of predation rests in the villagers' reaction to loss rather than the actual number of domestic stock taken.

Hunting is an important habitat factor, having contributed along with habitat loss to the present pattern of population fragmentation (Schaller 1977). Optimal conditions occur ill areas with negligible hunting of snow leopard and bharal.

IV. CONCLUSIONS

Main taining viable populations of snow leopards in the wild is a complex problem with no simple solutions. Obviously, a basic understanding of snow leopard ecology, the ecosystems they inhabit, and assessment of their current status are fundamental prerequisites to formulating any solutions. The planning, decision-making and implementation processes necessary for attaining longterm solutions require education and cooperation at all levels of society. We believe predictive species-habitat relationship models can enhance this goal.

The development of analytical models, even very basic ones, is simply the first step in the scientific process that must be followed by experimentation, i.e., attempts made to invalidate the hypthesis. The simple model presented in this paper is intended to stimulate thinking and to promote the concept of specieshabitat relationship modelling in the Himalayan region. In constructing this model, we have continually been hampered by a paucity of information. However, the lack of definitive knowledge of ecosystems and species responses is not sufficient reason to give up on the method. As Frankel and Soule (1981: 31) put it, ". . . Noah must have had similar critics to whom he probably remarked, °1 can either stand here in the rain arguing about precision, or I can start building."

Validation studies for this model will be undertaken next year, in western Nepal. Following this initial test phase and further analysis of data from our ongoing study, we will refine, redesign and calibrate the model more precisely. Multivariate statistical procedures of habitat use data will help to identify the most critical variables, to define relationships among variables (i.e., cumulative, limiting, spatial and strong or weak compensatory relationships) and in interpretation of model results. Variables will be quantified and combined to produce an overall habitat suitability rating system.

We also intend to develop and present standardized validation and habitat sampling procedures for use in potential snow leopard habitat. To this end, suggestions and criticism of concepts and content of this paper are welcomed.

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