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Patterns of Summer Habitat Use by Himalayan Snowcock (*Tetraogallus himalayensis*) in Nevada, U.S.A.

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Introduction

This paper discusses habitat use and daily activity patterns of an introduced population of Snowcocks in the Ruby Mountains of Nevada during the summer of 1981. This population originated from 1479 Himalayan Snowcocks released between 1963-1979, and is particularly interesting as an example of an apparently successful introduction of a gamebird to a new habitat. Many aspects of Snowcock natural history are poorly known because the species inhabits alpine and sub-alpine areas of central Asia. The most recent description of the general habits of wild Snowcock in Asia is in Ali & Ripley [1980].

Study Area

The Ruby mountains are one of several isolated "alpine islands" [Billings 1978] which dot the arid Intermountain Region between the Sierra Nevada and the Rocky mountains. The range is approximately 96km long and 13.5km wide. The orientation of the range is generally north-south, with an approximate 20° clockwise skew. The Rubies arise abruptly from the surrounding 1525m to 1675m sagebrush (Artemesia) basin. Several peaks along the range exceed 3300m. The alpine vegetation of the Ruby Mountains is essentially "a small, only slightly attenuated ... example of rocky mountain alpine vegetation" [Billings 1978]. Timberline is not well defined in the Rubies. Although most ridges exhibit an upper treeless zone, whitebark pine (Pinus albicaulis) can range up to 3230m in protected areas [Lewis 1971].

In the Ruby mountains Snowcock are apparently restricted to the southern half of a single township (T32N, R58E) where there are deep, elongated glacial cirques. After surveying this area by air and on the ground during autumn 1980, I concluded that the Snowcock population was centered in the Island Lake - Thomas Peak and Ruby Dome - Echo Lake areas. The Island Lake - Thomas Peak area was chosen for this study because it is only a four-hour hike from a major road, and because I was more familiar with the topography of that area. The study area is approximately 1.3km^2 and includes the northern portion of a major north-south ridge which has three small glacial valleys on its east slope and one on its north end. The lower limits of the study area were at about 3300m elevation at the bases of cirque walls. The southern boundary was marked by the absence of lush alpine turf vegetation on the south face of the Island Lake drainage [Fig.1].

Methods

The relative use of habitat types was measured by determining the distribution of intestinal droppings, and by systematic observation.

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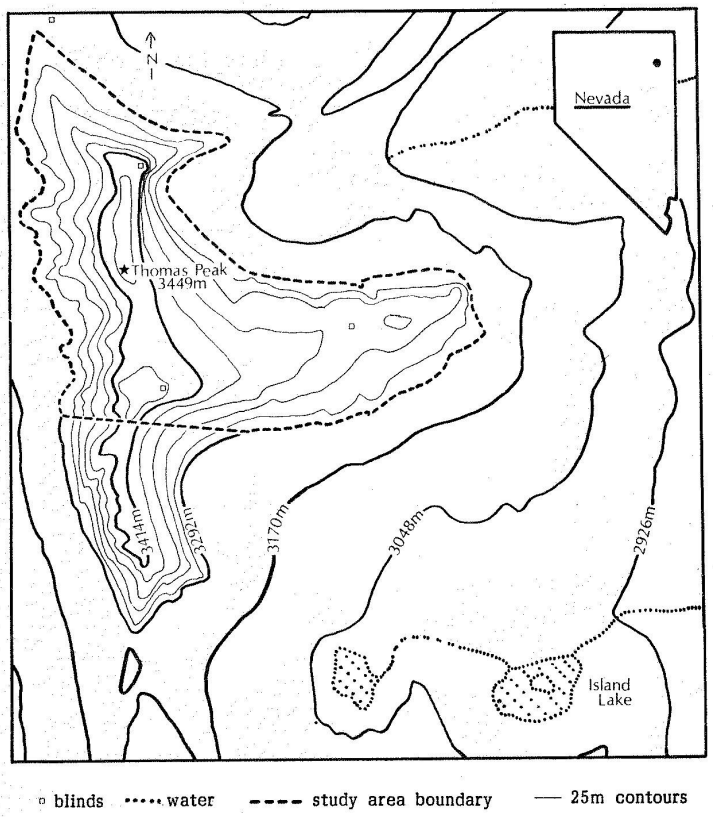

Figure 1. Snowcock study area in the Ruby Mountains, northeast Nevada (summer 1981).

However, the assumption that birds defecated uniformly in all habitats used was not tested. The importance of habitat types for foraging, resting, preening and roosting was also measured by observation. Observations of altitudinal movements and specific uses of habitat types were recorded daily. Spearman's rank correlation coefficient r_s, [Zar 1974] was used to test correlation between dropping densities and sample plot characteristics.

Dropping sample plots

The accumulation of droppings in 33 0.0025ha circular plots was monitored over 67 days from 10 July - 15 September 1981. The sample plots represented a stratified random sample, where the sampling strata were equivalent to five habitat types identified within the study area: 1) alpine turf [after Loope 1969], 2) alpine tundra, 3) rock ridges/cirque walls, 4) slopes and 5) scree slides. Habitat types were distinguished by both topographic and vegetative characteristics (Table 1).

The boundaries of habitat types were marked on a large aerial photograph of the study area (19 cm/km) during a preliminary week of vegetation reconnaissance, from 1-6 July 1981. A transparent grid was then placed over the photograph and 25 points were randomly chosen from the grid for each of the well-vegetated habitat types (alpine turf, alpine tundra and slope). In the field a 0.0025ha plot was then circumscribed around each point, and all old

Table 1. Characteristics of habitats used by Snowcocks in the Ruby Mountains, Nevada (summer 1981).

Habitat type	Slope	Plant genera	No. plots	% of study area	Mean % veg. cover	Mean % *Carex* cover	Mean no. dropping per acre
Alpine turf	variable	*Potentilla*, *Carex*	10	20.8	81.5	22.3	5940
Alpine tundra	25°	*Eriogonum*, *Phlox*, *Carex*	11	15.4	57.3	13.2	4050
Slope	25°	*Ribes*	12	35.0	42.9	11.1	2890
Rock ridges	very steep	Mosses, *Primula*	22	20.0	-	-	-
Scree slides	steep		0	8.8	-	-	-

droppings in the plot were collected. If the volume of old droppings in the plot did not exceed 0.5l, the plot was considered to be in non-preferred habitat. Only a general description of the topography and vegetation of such plots was recorded. If the volume of old droppings exceeded 0.5l. a dropping sample plot was established at the point, and plot parameters including exposure, degrees of slope, distance above talus accumulations, distance below canyon rim, percent bare ground and percent cover of major plant genera were recorded. Successive plots were tested for minimum use until approximately ten sample plots were established for each of the well-vegetated habitat types.

Rock ridge/cirque wall habitats were not sampled in the above manner because the birds used only small and specific portions of these rugged areas for habitual roosts and trails. Instead, a record was kept of the general topographic characteristics of all roost sites discovered during the study. The scree slide habitat was, by definition, too hazardous to work on, and was not sampled by the use of dropping sample plots.

Behavioural observations

Four rock hides were constructed where segments of four or five habitat types could be viewed simultaneously. These hides were used for behavioural observations over 85.3hr from 29 July - 7 August 1981 and from 6 September - 17 September 1981. All visible groups of Snowcock were scanned every 15 minutes with a 45X spotting scope [Altmann 1974]. The activity of each individual was recorded as feeding, resting (standing still or lying down), preening or dusting. To insure that Snowcock were not aware of my presence, I arrived at a hide just before dark ($\leq$ 2000 hr) and did not leave until that same hour the following day.

Results

Intensity of use of habitat types

In the well-vegetated habitat types, dropping accumulation was positively correlated with total vegetative cover (r_s = 0.678 $P < 0.10$). In particular, the average percent cover of carex showed a close relationship with average dropping densities in well-vegetated habitats (Table 1). These data also showed that alpine turf habitats were used most intensively, alpine tundra next, and slope habitats least intensively. Other sample plot characteristics which were measured were not significantly correlated with dropping densities ($P < 0.10$).

No data on intensity of use were collected in sparsely-vegetated habitat types, but general topographic features of three classes of roosts were recorded. Six roosts were located in 'snow shoots': eroded trenches which gorged the faces of steep rocky slopes. Most of these were accessible only from one or two narrow ledges. Birds roosted on the walls or bottoms of the trenches where the rock was broken off in a staircase fashion. Eleven roosts were located on narrow, precipitous rock ledges which were 100-175m above talus accumulations and 0-500m below canyon rims. Most could only be approached by travelling down the ridge itself. The mean slope above the roosts was 55° and the mean slope below was 68°. Five roosts were located at the base of rock faces or cliffs. Most of these were found near the edge of a meadow where a 1.0-3.0m strip of silt and gravel separated the rock face from the meadow. These roosts were similar to those used by young broods. The mean number of individuals in foraging groups was eight, and the largest cohesive groups numbered 15 and 17.

Behavioural activities

The birds use well-vegetated habitats marked differently from sparser vegetation. Systematic observations of Snowcock in sparser vegetation were limited however because these areas were most frequently used as night roosts. Some daytime hours were spent in sparsely-vegetated areas, especially for mid-day rests.

Younger broods (prior to the post-juvenal moult) roosted at night at the base of large boulders or cliffs near whichever meadow they had foraged in during the evening. By September (after the post-juvenal moult) broods joined adult groups at habitual roosts on precipitous rock ledges. By this date cold updrafts commonly blew throughout the night.

Well-established trails, used by both Snowcock and mountain goats (Oreamnos americanus), were commonly found on ledges across cirque walls, and at the crests of sharp ridges. Such rocky areas often lay between foraging areas and trails across them provided safe and direct routes between isolated foraging areas. The precipitous slopes below the trails were well suited for the Snowcock's plummeting escape flights. On many ridges and terraced cirque walls small patches of sod supported lush clumps of grasses (e.g. Tristeum, Poa), forbes (e.g. Primula parryi), willow (Salix), or currant (e.g. Ribes cereum, R. inerme). As Snowcocks moved through these areas they often pecked at these plants.

On eight of twelve afternoons, Snowcocks made their way up onto rock outcrops for mid-day rests. In a typical situation a large meadow lined the upper limits of a glacial cirque. Above the meadow a rock ridge, ranging from 3-20m high, formed the upper rim of the cirque. The other side of the ridge dropped off into another steep drainage. Adult Snowcocks feeding at the upper extreme of the meadow made their way up onto the ridge and settled down to roost for up to 30 min, then returned to the meadow to continue feeding.

Apparently the birds used all three well-vegetated habitats in a similar way, including feeding, resting, preening and dusting, but the extent to which each habitat was used depended on the amount of vegetation present. Most observations (83%) were made in alpine turf habitats because birds used this type more intensively.

During a typical 14.5hr day Snowcock :

1) fed throughout the day, but rested occasionally between 10.00 - 17.00hr

2) dusted most frequently between 06.00 - 08.00hr

3) preened at a low frequency throughout

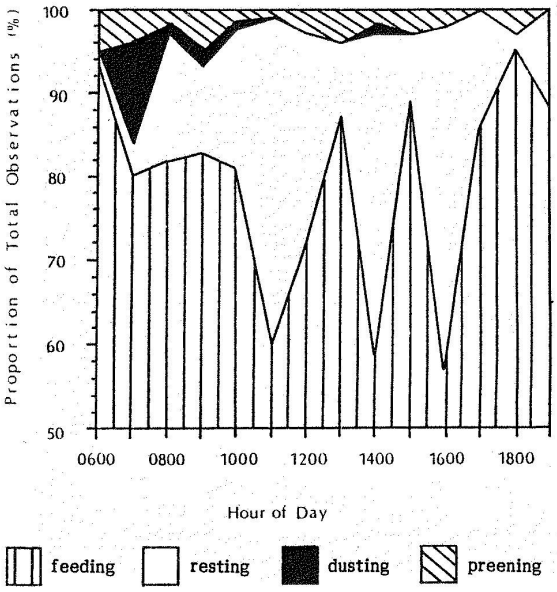

Figure 2. Frequency of Snowcock behaviours in the Ruby mountains, Nevada (summer 1981). Data from 85.3 hrs of scan observation where the scan interval was 15 minutes.

the day (Fig. 2).

Snowcocks generally fed vigorously throughout the day, but slightly slower during afternoon rest periods, and faster shortly before roosting. The food items most commonly taken were infloresences, stems, and underground parts of small herbaceous plants. The birds sometimes scratched and pecked at the sides of shallow trenches which they had dug in meadows to expose the underground parts of plants. Casual observations of dropping contents suggested **Potentilla, Carex, Trisetum, Deschampsia, Festuca, Poa** and grit made up most of the summer diet. The flowering parts of the woody **Potentilla frutiscosa**, and ripe berries of **Ribes** were also taken when available.

Dusting areas were found throughout the study area, and included tailings from Yellow-bellied Marmot (**Marmota flaviventris**) burrows, powdered dust on mountain goat trails, and natural sandy areas on some dry ridges.

Generalized daily activity

A daily activity schedule was constructed from approximately 100hr of daytime observation (Fig. 3). After a morning chorus at the break of day, Snowcocks flew from night roosts to meadows at the lower limits of the study area. They usually spent the morning making their way uphill, feeding all the way. Occasionally they stopped to dust or preen. By early afternoon they reached upper meadows, where they fed until late evening. Groups congregated on upper meadows in the evening, and just before dark walked or flew to roosts. The frequency of calling increased throughout the evening, and most days ended with an evening chorus given from the roost or very near it. The typical daily routine was occasionally disrupted when Snowcocks flew downhill to escape raptors.

Discussion

Both observation and sample plot techniques produced data on the intensity of use of habitats. However, observation data were biased because groups with young were more easily and consistently observed than groups without young. For example: for alpine turf habitats observations suggested 1.5 times more use than sample plot data; for alpine tundra and slope habitats 1.5 times less. Most young broods used a relatively small daily range including a few meadows and the rocky slopes surrounding them, though at least one brood was reared on alpine tundra. Those groups without young, on the other hand, travelled widely throughout the summer, and were therefore only observed occasionally. Daily ranges used by broods increased as broods matured.

Dropping sample plots were thus apparently superior to observation for determining intensity of use of habitats because plot data were collected randomly throughout the study area, and therefore should have represented use

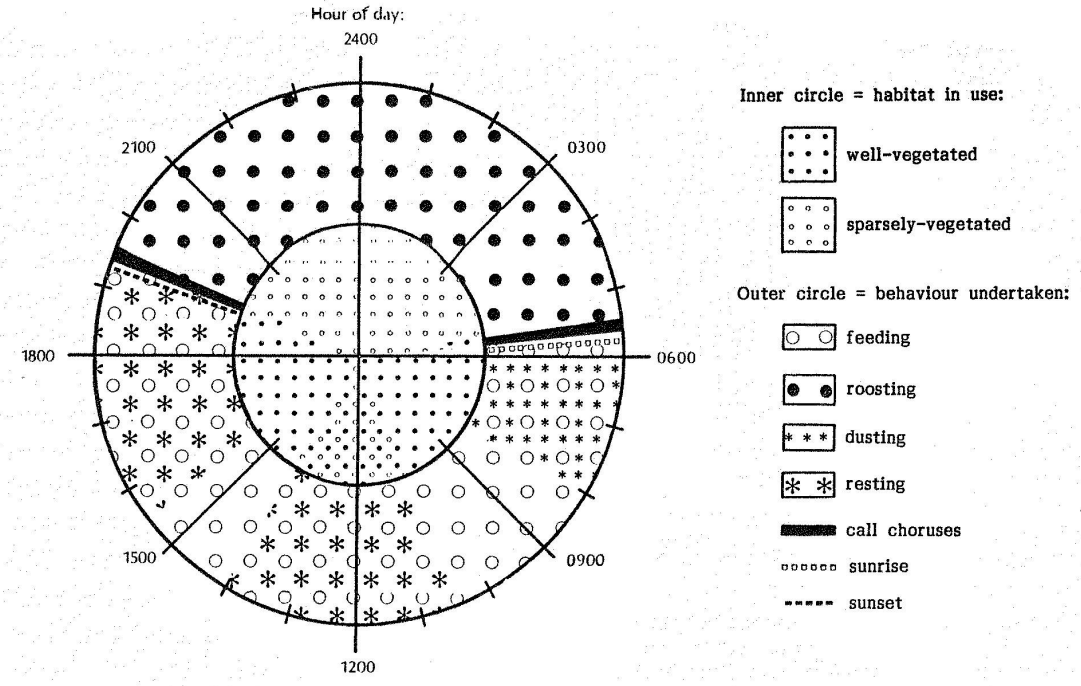

Figure 3. A generalized daily activity schedule for Snowcock in the Ruby Mountains of Nevada (summer 1981).

by all social groups. The underlying assumption (that birds defaecated evenly throughout the day) nonetheless remains to be tested.

Observations of behaviours may have also been biased toward brood behaviours, but observations of adults with young suggested that adults fed, dusted and preened at frequencies similar to those of young in first winter plumage. An exception was that on hot afternoons adults periodically rested for 15-30min in shade while young birds fed.

The limited number of deep and elongated glacial cirques in the Rubies has been suspected as a major factor which limits Snowcock populations [W. Molini, pers. commun.]. My findings show that lush turf meadows associated with these cirques are key areas for brood-rearing and foraging, and that the sheer rock faces in these cirques are important for roosts and escape flights.

The daily activity pattern described here corresponds well with that given by Ali and Ripley [1980] for Snowcocks in Asia. However, while they report that Snowcock "...shoot down from the hillsides in the early morning to drink ...", birds were only rarely observed drinking free water during the present study.

Acknowledgements

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DISCUSSION

M.W. Ridley noted with interest that Snowcock used cloud cover and steep slopes to avoid predation, and mentioned that Monal behaved in the same way. He suggested that these birds were foregoing the opportunity to exploit better feeding areas on the flatter slopes by remaining on the steepest ground.

J.D. Bland said it was not clear whether Snowcock prefered steeper slopes to avoid predators or because they contained better feeding areas.

R.A. Wani asked where the original stock had come from for the introductions in Nevada.

J.D. Bland replied that they had been captured near Gilgit; 137 had been taken, and now over 1400 had been released in the Ruby Mountains in Nevada.

K.C.R. Howman asked if the Snowcock project held any lessons for reintroduction policy.

J.D. Bland suggested that the main lessons were that any introductions were expensive and long term projects; careful monitoring of the results was vital. There were probably less than 100 Snowcock surviving in the wild in the Rubies now.

R.A. Wani recalled that Chukar had been introduced in Nevada and asked how they were doing.

J.D. Bland said that Chukar were very successful in the western U.S.; part of the reason might be that grass species from their indigenous range had been introduced before them providing the food to which they were adapted.

A.N. Mukerjee asked about the introductions of Grey Partridge Francolinus pondicerianus and Red Junglefowl Gallus gallus, to the U.S.

J.D. Bland replied that Perdix perdix had done well but the other species had not established themselves.

R. Howard asked what the policy behind these introductions was.

J.D. Bland said that 84% of the land was uninhabited by a native game bird species, so some had been introduced in the hopes of providing sport and revenue.

M.W. Ridley asked if Mr Bland agreed that the introduction of exotic species was positively irresponsible in ecological terms.

J.D. Bland said it was, except perhaps in the case of agricultural areas barren of native gamebirds.

K.C.R. Howman pointed out that there was no need to introduce gamebirds to India, where native species were sometimes abundant and could be cropped.

J.D. Bland said that the 'empty niche' theory which had motivated earlier exotic introductions

was largely discredited. There was now recognised to be no way in which introductions could avoid disturbing the ecology of an area. C.E. Knoder wondered if the birds released in the U.S. were captive bred or translocated from the wild.

J.D. Bland replied that some had been translocated at first but had rapidly dispersed; more success had been achieved with captive-bred birds. The programme deserved recognition for its success with rearing Snowcock in captivity.