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Overlapping sanctuaries: Complementary land utilization pattern among human beings and black-necked crane (*Grus nigricollis*) in the Phobjikha valley ¹

Abstract

The black-necked crane (Grus nigricollis) is an endangered migratory bird that winters in several valleys in Bhutan. These same valleys are home to many Bhutanese residents and their livestock. Protecting the cranes' habitat is a chief concern to the country's environmental community. Protecting black-necked crane habitat rests on an understanding of the crane and its habitat as part of a larger ecosystem, and necessitates an ecosystem approach to conservation and management. This paper presents the results of seven week study in the Phobjikha and Khotokha valleys of Wangduephodrang dzongkhag where the biological organism observed and studied was Homo sapien. The ranges, resource uses, and livelihood strategies of four communities is presented. Agricultural fields and enclosed pastures surround households. Migratory patterns of human residents relatively reduces crane-human interaction during winter months. Owing to the migratory pattern, neighbors within the same villages in Phobjikha can have their lands registered under different gewogs. Fuelwood collection areas.are within one-half hour walking distance. By volume, families burning softwood (conifer species), burn three times as much firewood as families burning hardwood species (such as birch and rhododendron). Thirty-one non-timber forest products were identified by local residents as having important household uses.

Introduction

The human residents of the Phobjikha valley have co-existed with the least known of all crane species for centuries. In the past 20 years, Bhutanese ornithologists and others from India, Europe and the United States have come to the Phobjikha valley to count and study the black-necked crane (*Grus nigricollis*) in its wintering habitat. However, the objective of the counts and studies was limited to population monitoring. In order to protect the habitat of this endangered species, natural resource managers must know about more than just the biophysical needs of the crane. They must understand the crane and its requirements as part of the larger Phobjikha valley ecosystem. It should be understood that a critical and highly influential component of this ecosystem is the *Homo sapien*.

The ecosystem approach to environmental conservation and management entails contextualizing the management or conservation concern as part of its larger ecological identity. The ecosystem approach begins its investigation through the interaction and interdependency of all of the organisms in the ecosystem hierarchy. A central tenet of the ecosystem approach is the incorporation of human beings as biological creatures. This is an important approach for managing protected areas as "it assumes that human beings cannot avoid decisions about natural resources,

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Since 1925 the Institute of Current World Affairs (the Crane-Rogers Foundation) has provided long-term fellowships to enable outstanding young adults to live outside the United States and write about international areas and issues. Endowed by the late Charles R. Crane, the Institute is also supported by contributions from like-minded individuals and foundations.

and that they should support these decisions with knowledge of the physical, biological and social relationships that define the ecosystem" (Lacier 1994). Natural resource decision-making involves both natural resource conservation, preservation, and utilization. Using this approach, the researchers set out to study the relationship of another biological organism to the Phobjikha valley ecosystem, the human being.

The study's objectives were to investigate the range and foraging strategies of the valley's resident population. The questions asked were: What are the residents' spatial distribution and patterns of land and forest use in the valley?, What are the residents' natural resource demands, and how are these met? and How do the lifestyles of human beings affect the cranes' habitat?

Black-necked crane (Grus nigricollis)²

Grus nigricollis, commonly known as the black-necked crane, or thrung-thrung in Dzongkha, is native to Central Asia and the Himalaya. The Russian naturalist, Przhewalski, "discovered" the crane in 1876 in north-east Tibet (Walkinshaw 1973). A migratory bird, it breeds in areas of Ladakh through Tibet and into the southern provinces of China. During its annual migration, the crane winters over in Bhutan for five months between the end of October and the beginning of April (Figure I). Other wintering grounds are found in southern areas of China and Tibet. Cranes are known to winter in several valleys in central and eastern Bhutan, the largest groups found in the Phobjikha valley (elevation 3000 m) of central Bhutan and in Bumdeling (elevation 1,950 m) in northeastern Bhutan. Approximately one-third of the world's black-necked cranes, numbering over 300, winter in Bhutan.

The crane has only been a serious topic of study in Bhutan since 1978 (Gole 1989). Study has been primarily restricted to crane counts conducted by the Royal Society for the Protection of Nature (RSPN), and basic ethological observation by a few amateur and professional ornithologists.



The Phobjikha valley is one of the few flat and wide valleys (approximately 2 kms at its widest point) in Bhutan. It is a seasonally-wet U-shaped valley containing several small marshes. Evidence of glaciation can be seen in the moraine projecting from the base of the hill where Gangtey monastery stands. An important roosting area for the cranes lies adjacent to this geologic feature of morainic deposits from the retreating glacier. Located in the proximity of the Black Mountain region of Central Bhutan, geologically Phobjikha soils are composed of quartzites and conglomerates. These soils have been classified by the Geological Survey of India as the Nake Chu Formation (United Nations 1991).

The valley is encircled by steep slopes with distinct floristic stratification. In the northern valley region, the lower slope, adjacent to the valley floor, is dominated by blue pine (*Pinus wallichiana*) with hardwoods such as birch (*Betula utilis*), several species of rhododendron and maple (*Acer spp.*) in the understory. Proceeding upslope, the species composition changes to spruce-fir with suppressed hemlock (*Tsuga dumosa*) and rhododendron in the mid-story. In areas where the crown cover (canopy) is breaking-up (signifying a forest in the understory reinitation phase), the canopy is sparse - dominated by hemlock. Blue pine, dwarf bamboo (*Arundinaria maling*), *Pteridium* fern and herbaceous species such as *Primula sp.*, *Rubus sp.*, and *Fragaria sp.* comprise the understory regeneration. Forests in the southern valley region are richer in hardwoods dominated by birch, maple, and rhododendron.

Thick dwarf bamboo carpets the valley floor. Grazing by cattle, horses, and sheep stunts bamboo growth so that it rarely exceeds heights of 40 cm. Exclosures and undisturbed areas are quickly overtaken by dwarf bamboo that grow up to more than 150 cm. Gentle slopes immediate to the valley are covered with a variety of grasses and flowering plants. Livestock are also found grazing here. Farmers' fields, planted with wheat or barley, in the winter, and potatoes in the summer, are adjacent to both the forest and valley.

The local fauna include wild boar (Sus scrofa), sambar deer (Cervus unicolor), muntjac (Muntiacus muntjac), Himalayan black bear (Selenarctos thibetanus), leopard (Panthera pardus), and red fox (Vulpes vulpes). According to Inskipp et al. (1993), there are over 62 species of bird in the area (Appendix I).

A slow-flowing river, called the Nakey chhu, meanders through the center of the valley. The width of the river ranges between 1 and 1.5 meters in the roosting area, located in the northwestern region of the valley, and increases in width, approaching three meters, as it flows southeast (Figure 2).





At the end of the rainy season (late September), river depth ranges between 40 cm and 60 cm in the roosting area. The hottest and wettest months coincide in July. January is the coldest month with minimum temperatures dropping below the freezing point.



Figure 3. Climatological data for Phobjikha over the last ten years (1985-1994).

Cranes take advantage of the diverse landscape, feeding in agricultural fields and foraging throughout the finger-like projections extending from the eastern side of the valley. The total size of the feeding-foraging ground is approximately 2,277 hectares. The cranes roost in two marshy areas. The primary roosting ground, at the base of a small knoll, and in a secondary roosting area, in the northwestern extension of the valley.

Government services include a basic health unit, a primary school through class 5, a high altitude livestock development program and veterinary center, a communication center, and an agricultural extension service. The Bhutan National Potato Programme has a demonstration farm in Phobjikha. The total population in the valley in 1993 was 4, 125 individuals. This reflects a growth of 2.3 % from the previous year. The valley's population has increased 5 % since 1990 (Figure 4).



Figure 4. Phobjikha valley human population (1990 - 1993) Source: Basic Health Unit, Phobjikha (1994)

Village description and history - Aekho

Sixty-four people live, under the shadow of Gangtey Gonpa, within a cluster of six houses called Aekho. One residence houses two families. Six of the seven families are migratory. The village is one of five in the northwestern extension of the valley. This portion of the valley is the northern limits of the crane's foraging area. There is a small marsh in between Aekho and the next village, Santena, where a few crane families roost.

On average, families own 6 langdos of dryland³ in which they plant potatoes and a combination of wheat and barley. Families also grow a variety of vegetables and greens including, turnip, radish, spinach, onion, cabbage, garlic, and coriander.

Livestock in the area include pigs, cattle, horses and chicken. Two of the seven households do not own milking cows. They either purchase dairy products or barter rice for them. Aekho's households fall under Gangtey *gewog* (a political administrative unit) administration except for the village's founding family whom fall under Bjana gewog administration. The families of Aekho have a second house near the gonpa, and a third house, where they cultivate paddy fields, in a lower and warmer elevation. Before Aekho became the settlement it is today, the servants to the monks at Gangtey Gonpa grazed their livestock in the pastures surrounding the present village (Cattle and livestock are not allowed in areas immediate to a gonpa). Over time, they built permanent structures in Aekho, moving there permanently.

Village description - Khewang

Khewang is a small cluster of four houses located at the mouth of an eastern extension of the Phobjikha valley. It is the closest human settlement to the black-necked crane's primary roosting

area. Three of the four families are migratory. One family left for their winter home, in Ada, the second week of September, and could not be included in the study.

The families of Khewang own two, seven and fifteen langdos of land respectively. Cultivated crops are similar to those in Aekho and include wheat, barley, buckwheat, radish, turnip and potato. Domestic animals include chickens, pigs, horses, sheep and cattle.

Two of the household incomes in this village are the highest in the study area. Two families are enterprising potato farmers bringing three to four lorry loads of potato to Phuentsholing each year. Each lorry-load holds eighty 100 Kg bags. In October 1994, the auction rate was Nu. 3.51-4.51 per Kg. One family has no monetary income. This elderly couple consumes all that they produce and trades some of their average annual potato harvest - 300 Kgs - for other necessary supplies.

Village description - Gedechhen

Located at the southeastern end of the valley, Gedechhen is on a west facing slope, overlooking the Ma chhu. In comparison to other villages surrounding the Phobjikha valley, it is a large settlement. In the winter, all of the families migrate to Rukha in Ada gewog.

Family size ranges between seven and 20. Landholdings are smaller here. Families, on average, own two langdos of dryland. Wheat and sweet buckwheat, or *geray*, are the primary cereal crops. Unlike the other study sites, families in Gedechhen do not auction potatoes in Phuentsholing. Potatoes are cultivated in small plots within kitchen gardens (Figure 5 and 6). Villagers trade potatoes with shopkeepers in Tabating for food and household provisions at a rate of Nu. 2.4 - 2.6 per Kg. The incomes of Gedechhen residents are the lowest in the study area. Families do not have significant incomes from potato farming. Occasionally, people sell *datshi* and eggs or rent out their horses for transport. There is one wood carver in the village who works for Nu. 100 per day plus meals, or on a fixed-fee contract.

Being migratory, families do not keep sheep. The other livestock maintained in Gedechhen are the same as in the other study site villages.

On the village's eastern edge, a monastery acts as an informal monastic school for several of the villages children. None of the children attend the school in Phobjikha.





Khotokha valley

The Khotokha valley is a smaller wintering area for the black-necked crane. In 1993, there were 10 cranes wintering in the valley. The valley is located approximately 18 km west of the Phobjikha valley at an elevation of 2,700 meters. The roosting area is located in a stand of dying pines at the southern end of the valley. The cranes forage and feed freely throughout the fields and grasslands of Khotokha.

The northern and central portions of the valley are dominated by grasses which are heavily browsed by cattle and horses. The Pangza chhu and Ghe chhu are the two major streams flowing through the valley. The dwarf bamboo, found sprouting throughout the Phobjikha valley, is less dense and less frequent in Khotokha. A local legend predicts that once the dwarf bamboo establishes itself within the area separating the two rivers, the world will end.

The human settlement pattern in Khotokha differs from that found in Phobjikha. The majority of the villages are clustered at the valley's northern end. Three small and scattered villages are located on the east-facing slopes. There are very few houses along the eastern side and southern end of the valley.

A large-scale logging operation exists in Khotokha. A cable ropeway, constructed between Tashila and Chuzom, transports harvested timber and local resident with their goods between the two sites. A road is currently being built along the valley's eastern edge to assist the commercial logging operation in the area. Although there is no motor road leading into Khotokha, tractor paths run the length of the valley. Dismantled tractors are taken in the ropeway to Khotokha. Upon reaching the valley, the tractors are reassembled.

Support for the ropeway and the logging concession was enhanced by the claim that it would benefit the local people. It appears that only tractor owners and contractors are reaping the benefits of the logging operation and ropeway's construction. They transport sacks of potatoes to the ropeway, and as will be discussed later, fuelwood to houses.

There is both a primary school and an animal husbandry extension office serving local residents.

Village description - Balegonpa

Moving south from Khotokha's major settlement, Wachey, are four scattered houses that extend down to the local primary school. Moving west towards the valley's center is a large solitary house. During the feudal history of Bhutan, the local landlord lived here. The residents of these previously mentioned houses were the landlord's former workers. This is the village of Balegonpa.

Family size ranges between two and nine. Several of the children attend the local school. Each household owns an average of five langdos of land. With a slightly warmer climate and longer growing season than in Phobjikha, families are able to cultivate apples, maize, chilis, tomatoes, pumpkin, cucumber, *Amaranthus sp.*, and peas, in addition to turnip, radish, spinach, potato, and onion. Potatoes are auctioned annually in Phuentsholing. Villagers keep pigs, chickens, horses and cows.

Half of surveyed households are migratory, moving to Bjana in the winter. The remaining households are permanently settled. Located almost in the center of the valley, the former landlord's residence is the closest occupied structure to the crane foraging habitat. Thus this family is quite knowledgeable on the movement and arrival of valley's cranes. The other permanently settled family is the caretaker for a local monastery.

Methodology

Research was conducted in two phases - before and after the arrival of the black-necked crane. The first phase of research, residing in three villages in the Phobjikha valley, and in one village in the Khotokha valley for periods of five to seven days, took place during a six week period between 5 September and 12 October, 1994. In each village, data collection involved the following techniques: participatory rural appraisal, and participant observation, an ethnographic technique. A line transect through each study site and adjacent environs measured the actual distance between different land use practices and black-necked crane habitat. Village sketch maps, likewise, display the distribution and arrangement of land holdings with relationship to each other and crane habitat. Seasonal and gender division of labor calendars document family work and migration patterns. Vegetation transects and personal interviews determined the non-timber forest products extracted by each community.

The Phobjikha valley was mapped to delineate the approximate crane roosting, foraging and feeding grounds.

a. methods for estimating daily fuelwood consumption

Each morning with the assistance of a family member, a bundle of fuelwood was stacked, measured, and put aside (Figure 7). Family members were instructed to use only firewood from this pile until the same time the following morning. To avoid complete exhaustion of the bundle, the assisting family member was asked to estimate and help stack enough firewood to last for one and one-half days. The following morning the remainder of the previous day's bundle was measured. The difference in volume was considered the consumed volume. A new bundle was stacked.

To reduce error from air space, each bundle was carefully stacked. The calculation for bundle volume is based on the formula, $(1/2)\pi R^2 L$, half the volume of a cylinder. The average of three length and circumference measurements was used in the calculation. The radius of the bundle was found by calculating the average of R from the bundles' two diameter measurements (D=2R) and the one from its height measurement (H), and one from the circumference (W).



Figure 7. Firewood stack for measuring fuelwood volume

The fuelwood consumption portion of the study also entailed visiting each village's fuelwood collection areas with a member of the community. The borders of the collection area were delineated with local residents and while doing so, the study site history was gathered including granting of collection rights, and major disturbances such as fire and significant tree falls from high winds or snowfall.

All statistical analyses were performed on SYSTAT Version 5.0 and Microsoft Excel 4.0.

The second research phase took place during 19-20 November. The researchers returned to the Phobjikha valley to observe crane foraging and roosting. This information is supplemented by personal observations of one of the authors during 1988, 1989, 1991 and 1993.

RESULTS AND DISCUSSION

Forest products

a. non-timber forest and botanical products

Residents gather a variety of non-wood forest products from fields, degraded lands and forests surrounding their villages. Non-wood products have a multipurpose role in the subsistence lifestyles and livelihoods of the residents. They serve as foods, medicines, household accessories, religious symbols, and livestock requirements. During ethnobotanical transects and firewood

collection site demarcation, residents identified 31 species that they regularly utilize. The species list is found in Appendix II.

b. Fuelwood collection

Each surveyed village has government-granted *usufruct* rights (rights of use) based on their past traditional rights systems. These rights have been granted to a finite forest area for the sole purpose of collecting fuelwood. The physical limits of each fuelwood collection area are bound by landforms such as rivers, ravines, or footpaths. Users are permitted to fell two live trees a year *gratis* from the government. These two trees must be marked by a forest guard before cutting. Users are free to gather all woody debris and treefalls as fuel, but they must report treefalls to the forest department before harvesting the timber.

The laws governing usufruct rights are transformed by changes in land and forest ownership. The feudal land tenure system in Bhutan was abandoned in the early 1900's. Under the feudal system, landlords had rights to the forest. They allocated use rights to their tenants. This was the case in Aekho. When Aekho had only one household, this one family had exclusive rights to the forest. When settlers arrived, they had to ask this family for permission to gather fuelwood. It was not until twenty-eight years ago, with the passing of the Land Act in 1966, that the government reallocated forest resources, granting the other six families in Aekho usufruct rights to their own site. For this reason, the villagers of Aekho have rights to two sokshing, fuelwood collection and construction timber extraction zones. Six families share one parcel. The village's founding family retains its original site.

There is no informal management regime among the users with regard to the fuelwood collection site. The general feeling among residents is that individuals respect the rules of access within each collection area. It is the belief among some families who migrate from Phobjikha in the winter, that families who winter in Phobjikha probably collect fuelwood from their collection sites. Those believed to be committing such acts have not yet been granted usufruct rights to their own sites. Residents with rights to fuelwood collection areas do not collect wood from other forested regions, even if that particular tract has not been granted to another village or is closer to their own village.

The felling of trees and collection of downed wood from fuelwood collection zones, and the raking of leaf litter for cattle bedding affect the development of the forest stand (eg. the removal of nutrients, the creation of microsites, and changing light regimes).

With each village having its own designated fuelwood collection area, the impact of fuelwood extraction is restricted to a definable area. Residents of Aekho have rights to two fuelwood collection areas due west of the village. The sites, on an east facing slope, are less than 500 m from the village. One household (AH5) has exclusive rights to the larger of the two sites. This family also uses the area as its sokshing. The site is a monospecific stand of blue pine.

Khotokha residents do not collect fuelwood from the surrounding forest. Instead, they are allowed to and collect the discarded processed timber from the landing site. This saves the time spent looking for suitable downed branches and logs and the burden of carrying a backload of fuelwood. While individuals must still walk to the landing site, they can save this travel time if they hire a tractor to deliver the fuelwood to their houses. A tractor load of fuelwood (softwood species) lasts three weeks to one month. However, the transport fee is Nu. 140 per trip, and sometimes even up to Nu. 200, depending on the distance of the house from the sawmill.

Daily consumption patterns

Fuelwood consumption was measured daily during the researchers' residence in each village. the 20 families observed only one uses a *bukhari* (wood-burning stove); the remaining 19 all use the same traditional Bhutanese stove. This stove, with an internal fire, is made of stone or bricks packed in mud (Gujral 1991). Stoves may have anywhere between two and four fire holes rimmed with three lumps of clay or stones to rest the pot on top of, and one or two fire boxes, depending on the stove's size. Both hardwood and softwood species are burned as fuelwood. The most common hardwood species include birch, maple, and rhododendron. The most common softwood species is pine. Hardwoods are preferred over softwoods because they burn longer, generate more heat and less smoke, and leave less ash behind.

Average daily consumption figures, measured in cubic meters, are shown in Table I. The average daily volume of fuelwood consumed by hardwood users ranges between 0.78 m³ and 0.135 m³. The average daily volume of fuelwood consumed by softwood users ranges between 0.094 m³ and 0.273 m³.

House No.	Family	Firewood	Average daily	Use per capita	Standard unit(m3)
	size	type (H/S)	consumption (m ³)	<u>(m³)</u>	3H = 1S
Aekho					
H1	5	Softwood	0.223	0.0446	0.223
H2	9	Softwood	0.201	0.0223	0.201
H3	9	Softwood	0.102	0.0113	0.102
H4	14	Softwood	0.125	0.0089	0.125
H5	8	Softwood	0.142	0.0177	0.142
H6	14	Softwood	0.155	0.011	0.155
H7	5	Softwood	0.222	0.0444	0.222
Khewang					
H1	8	Softwood	0.184	0.023	0.184
H2	10	Hardwood	0.135	0.0135	0.405
H3	2	Softwood	0.114	0.057	0.114
<u>Gedechhen</u>					
H1	20	Hardwood	0.095	0.0046	0.285
H2	9	Hardwood	0.112	0.0123	0.336
H3	9	Hardwood	0.086	0.0096	0.258
H4	7	Hardwood	0.078	0.0111	0.234
H5	14	Hardwood	0.116	0.0083	0.348
H6	7	Hardwood	0.078	0.0111	0.234
Balegonpa					
H1	2	Softwood	0.094	0.047	0.09
H2	9	Softwood	0.273	0.0303	0.273
H3	7	Softwood	0.171	0.0244	0.171
H4	4	Softwood	0.193	0.0482	0.193

Table I: Household fuelwood consumption patterns for study villages in September - October, 1994.

To determine differences between the populations of hardwood and softwood users a two sample F-test was conducted. Results of this test given in Table II show that there was little variation

within the population of softwood users. Conversely, there was significant variation within the population of hardwood users. Probable causes for this variation include family size which ranges between 7 and 20 members and the amount of alcohol produced. The most significant finding of this analysis is the difference between the two populations (p = 0.0002). Softwood users consume approximately three times the amount of fuelwood of hardwood users.

F-Test: Two-sample for variance				
	Softwood	Hardwood		
Mean	0.030033	0.010117429		
Variance	0.000268	8.57282E-06		
Observations	13	7		
Degrees of freedom	12	6		
F	31.21601			
P (F<=f) one-tail	0.000207			
F critical one-tail	3.999929			

Table II: F-test analysis of variance between hardwood and softwood users in the Phobjikha Valley for September - October, 1994.

A regression analysis was conducted to determine if a correlation between family size and average daily fuelwood consumption existed. To run the analysis, all fuelwood users were standardized using the formula; S = 3H. The standardized units are listed in Table I. The results indicated that there was no significant correlation (Figure 8) between family size and daily average fuelwood consumption ($R^2 = 0.16$). This indicated that factors other than family size influenced the amount of fuelwood consumed. Some probable factors include: seasonality- more cooking occurs during the working months when villagers hire help to work on their farms; alcohol brewing and *zao* frying (to make a rice snack), activities that may occur once a week or twice a month and consume extra fuelwood.

Tightness of fit



Figure 8: Regression line showing tightness of fit for average daily fuelwood consumption and number of household members.

Seasonal migration and crane habitat

The majority of families migrate from Phobjikha in the winter to their homes which are located in the area they refer to as "Melokha", loosely translated as "lower down", meaning low elevation where rice grows. All winter homes are in Wangduephodrang district. Families spend the harsh Phobjikha winter months, with their animals, at lower, warmer elevations. Families from Aekho migrate to Pchitokha, Tekey Zam, and Bjana. Families in Khewang migrate to Ada, a one day's walk, southwest of Phobjikha. In Gedechhen, all of the residents move to Rukha. Villagers of Balegonpa migrate between Bjana and Khotokha.

Villagers, in consultation with their gup, village headman, set the date when their families and livestock may begin migrating between summer and winter homes. The gup possesses the authority to overrule the villagers' decision. The moving date to the winter home is on or about the 15th day of the 9th month (mid-October in the Roman calendar). By this time in Phobjikha and Khotokha, the potato harvest, ploughing and sowing of wheat is complete. In the winter homes, the end of the rice harvest nears. The migration date is set to coincide with the completion of the rice harvest. Individuals move to winter homes before the finalized migration date to begin the harvest. To prevent crop predation, livestock are restricted from the wintering villages before the end of the harvest. Livestock driven to the winter homes before the date must pay a penalty to the village common granary. The fine of 10 to 20 *dreys* of rice or wheat ⁴ per livestock head per day is used throughout the year during village festivals or when hosting important government officials. Families with children, shift to their winter homes after school closes, on or about December 18th.

Drawing near to the 15th day of the 3rd month, families must return their livestock to their summer homes. During the third month (mid-April in the Roman calendar), the wheat harvest is nearly finished in Phobjikha and Khotokha, but more importantly, it is the beginning of rice cultivation season in the winter home. Again the same penalty holds, if after the set migration date, livestock still remain in the winter home, where they can interfere with the paddy.

With the cranes' arrival at the end of October, crane-people interaction is greatest during the first six weeks of the wintering period. According to observations by Chacko (1992), the maximum number of cranes reach both Phobjikha and Khotokha by mid-November. By then most of the migratory people have already moved to their winter homes. Crane-people interaction is relatively low. However, there is still a significant number of non-migratory families living in the side valleys and in the commercial area along the motor road in Tabating. Visitors also frequent the valley to observe the cranes at this time before the road becomes impassable due to heavy snow.

Time-budgeting

Time budget studies are useful tools for comparing how technological innovation and policy changes affect the use of time within and between societies. Time budget studies show the allocation of limited resources (time, energy, and manpower) towards daily activities necessary for the family's survival. Time can be thought of in four different ways: in its social meaning, as a causal link in the explanation of change, as a measure of quantitative relationship, and as a qualitative measure of change (Burch and DeLuca 1984). In the context of this study, the time

budget was limited to a qualitative description. This is an evolutionary time budget study, i.e. a particular political economy is investigated to compare against different or the same political economies within the country (Burch and DeLuca 1984). In this study, the potato farmer's political economy was investigated.

Both male and female adult family members rose every morning between 5:30 - 6:00 am. The first activity of the day for women is to start a fire for suja preparation. This same fire was kept burning for three to three-half hours for preparation of food stuffs. The women prepared the morning meal, boiled radish and turnip greens to feed to pigs, and boiled water to prepare a wheat or barley flour dough that was fed to young calves. While some women prepared food, other family members (men, women, and children) were leading horses and livestock out of their stalls on the ground floor of the house and into enclosed or open grazing pasture.

By mid-morning all of the cows were milked. Young calves were fed dough to compensate for the lost milk. Some milk was set aside and boiled for sweet tea. The rest was poured into a wooden churn for making butter. Preparation for the second meal of the day began and was eaten shortly after 11:30 a.m.

Afternoon activities varied. One to two hours may be spent in an open field or enclosed pasture cutting grass for fodder, or raking leaf litter for bedding in the cattle shed. The bundled grass was stored under the house eaves for drying. Firewood was collected at least twice a week. In all of the villages studied, the walking distance to the fuelwood collection site is less than 30 minutes. Thirty to 45 minutes was spent looking for suitable downed logs and branches, and chopping them to form a manageable backload. In the village of Aekho, men did not gather firewood. They felled trees marked by forest department officers and chopped these and fallen trees into transportable pieces. Chopped firewood was stacked in the forest for the women of the households to bring to the house when necessary. For women in Aekho, firewood collection takes less than an hour at a time (including travel time). Before assembling wood into a backload, women looked for *Pteridium* fern to cushion their backs.

The afternoon meal was prepared and eaten at approximately 4:00 p.m. For families choosing to forego this meal a snack of *suja* and *zao* was taken in its place. Every evening between 5:00 and 6:00 p.m., the cattle and horses were rounded up and brought back to the village. They were put in stalls for the night with either fresh or dried fodder grasses or crop residues. Preparation of the fourth and final meal of the day begins between 6:00 and 6:30 p.m. This is a leisurely meal that lasts for any time between 1 and 1 hours finishing between 8:00 and 8:30 p.m. The last family member retires for the day shortly before 10:00 p.m.

During our work in Khewang, all family members spent four hours every morning and five to six hours in the afternoon packing potatoes for the auction in Phuentsholing. In Khotokha, the stalks of the previously harvest maize and *Artemisia* were cut for and the remaining vegetation cleared from the field for the winter.

The time budget study was supplemented by seasonal labor and gender-disaggregated calendars. These calendars identified livelihood tasks, labor constraints, gender-specific responsibilities, and highlighted the rhythm of the migratory pattern.

Table IIIa: Seasonal lab	or and gender-disaggregated (calendar for a non-migrator	y family (AH1) of
First month	<u>Summer home</u> Plow fields	Winter home	<u>Responsibility of</u>
	Repair fences		AD, MC
Second month	Plant potato		AD, AF, MC, FC
Third month	Chop firewood		AD, MC
Fourth month	Weed potato, barley &		AM, AF
	wheat fields	Transplant	AF, MC, FC
		rice paddy	АМ
Fifth month	Harvest wheat	Finish rice transplanting	AM
	& barley		AM, AF
Sixth month	Harvest wheat	Weed rice	AM, AF AM
Seventh month	Dig potatoes		AM, AF, MC, FC
Eighth month	Manure & plow fields for		AF
	wheat / barley Sell potatoes		AM AM, AF
Ninth month		Harvest paddy	АМ
	Sell potatoes Sow wheat		AM, AF AM, AF
Tenth month	Collect & chop firewood		AF, AM, MC, FC AM
Eleventh month	not much work as it the middle of winter. Husband is a gomchen and performs the choku, the annual puja, for many families in the Phobjikha valley		
Twelfth month	Perform choku		AM

* Seasons are based on the Bhutanese (lunar) calendar. The first month begins in the middle of February. AD= adult male, AF= adult female, MC= male child, FC= female child. Family does not have a house, only land, in a region where rice grows. The husband, and occasionally, the wife moves to Dapu.

Table IIIb: Seasonal 1	abor calendar for a non-migratory family (BH2) of Khewang, Phobjikha
First month	manure and plough fields
Second month	plant potato
Third month	chop firewood, weed potato fields, and rake litter for cattle bedding
Fourth month	weed potato field again, drive sheep up to higher altitude summer grazing grounds
Fifth month	harvest wheat
Sixth month	harvest wheat
Seventh month	dig potato
Eighth month	plough potato fields and pack and sell potatoes in Phuentsoling take time for Gangtey Tshechu (3-5 days)
Ninth month	sow wheat, make another trip to sell potatoes, and draw together the sheep and drive them down to Phobjikha for the winter
Tenth month	buy rice and other provisions from Sha in Wangduephodrang district, collect and chop firewood
Eleventh month	work is sporadic as this is the middle of winter
Twelfth month	annual choku



Returning from the forest. Baskets of Rhododendron leaves for cattle sheds.

Table IIIc: Seasonal labor calendar for a migratory family (AH6) in Aekho, Phobjikha			
	Summer home - Aekho	Winter home - Bjana	
First month	Some family members return to prepare potato fields Split firewood	Some family members remain behind	
Second month	Continue ploughing and weeding fields Repair fencing	Remaining family members and livestock return to Aekho	
Third month	Firewood collection Plant potato Weed wheat fields		
Fourth month	Harvest half of the wheat crop Some family members pack belongings and return to Bjana	Flood paddy fields Transplant rice paddy	
Fifth month	Finish wheat harvest at the end of the month	Transplant rice	
Sixth month		Cut and bundle fodder grasses Weed paddy	
Seventh month	Harvest potato		
Eighth month	Pack and sell potato Manure, plough and sow wheat Time off for Gangtey Tshechu (3-5 days	3)	
Ninth month	Family and livestock move to BjanaHarvest paddy		
Tenth month		Repair fencing	
Eleventh month		Collect and chop firewood	
Twelfth month			

Table IIId: Seasonal labor calendar for a migratory household (CH3) of Gedechhen, Phobjikha			
	Summer home - Gedechhen	Winter home - Rukha	
First month	Some family member return to Gedechhen	Some family members remain behind to prepare fields for potato	
Second month	Rake litter for cattle bedding Collect firewood Plant potato		
Third month	Harvest wheat and sweet buckwheat		
Fourth month	Manure and plough fields	Flood fields and transplant rice	
Fifth month		Remaining family members and livestock migrate back to Gedechhen	
Sixth month	Harvest wheat and potatoes		
Seventh month			
Eighth month	Manure and plough fields for wheat Take time for the Gangtey Tshechu (3-5 days)		
Ninth month	Sow wheat at the beginning of the month Family members and livestock migrate to Rukha	Harvest rice	
Tenth month		Prepare field for sowing wheat	
Eleventh month		Plant buckwheat	
Twelfth month		Weed wheat and buckwheat	

Conclusions and recommendations

This study, examining the human population in the Phobjikha Valley, highlights major points with respect to the valleys management as the wintering habitat for the endangered black-necked crane. By investigating the ranges of the human population and their resource utilization patterns, the co-existence of the black-necked crane and human being in the Phobjikha valley can be assessed.

The lifestyles and livelihood patterns of the local residents have many positive effects on the crane habitat. First, their migratory patterns, leaving the valley when the crane population is at its highest density, reduces the interaction between the two species, and the potential for confrontation. Second, agricultural fields have cleared additional foraging areas for the crane. The field ploughed before the onset of winter provide the cranes with easy access to insects and plant material in the over-turned soil. Livestock, namely cattle, sheep, and horses, help control grass and bamboo regeneration in the cranes' foraging areas.

Bishop (1989) points out that the decrease of cranes wintering in Bhutan is influenced by activities occurring in the other environs frequented by the crane, namely social and political conditions in the Xizang-Qinghai Plateau in China. Chinese nationals in Tibet hunt the crane (John MacKinnon pers comm). However, there could also be other underlying causes for the decrease of wintering cranes in Bhutan, such as migration to other areas. Such information and much else on the cranes' exact migratory patterns and routes are wanting. Collaborative efforts should be initiated by researchers from all range countries to band, mark, or tag some of the birds and monitor them. Dissemination of such data would fill in the information gap currently existing. Only after knowing where the wintering birds breed, or vice-versa, would it be sensible to deduce why changes, if any, occur in the population. At that time, causal factors could be investigated and appropriate measures taken.

Having the cranes winter in Phobjikha produces some benefits to the local human population. The opening of Bhutan's borders to controlled tourism, and capitalizing on its intact environment, means that during the fall, the cranes become a tourist attraction. Since 1988, guests houses have opened and numerous small shops now line the paved roadway. The economic benefits of tourism, though, are limited to those individuals involved directly with tourists. Most local villagers do not receive any of the benefits associated with tourism.

Tourism, though, may have negative effects on the cranes. During the peak seasons, October and November, the compulsion to obtain a crane photograph may cause undue disturbance to the cranes during feeding. If the proximity of tourists to the crane is indeed causing it harm, tourist guides should be instructed to forewarn tourists that an optimum distance must be maintained while photographing the cranes so as not to cause the cranes stress.

Some farmers believe that by feeding in their fields, cranes reduce the number of crop insect pests (Gole 1989). To facilitate field feeding, residents should be encouraged to construct the traditional fences around agricultural fields of wooden planks and rocks. This is more effective against crop predation by animals than barbed wire fences. There are several barbed wire fences adjacent to and near the crane habitat. The barbed wire fences are the result of a government subsidy. While barbed wire is an appropriate deterrent to crop predation (from cattle), it is harmful to the crane.

After snowfall, the wire is invisible. Occasionally a crane damages a wing on the wire and cannot join the rest of the flock when it departs from Phobjikha.

Currently fuelwood shortage does not seem to be a problem. Sustainable rationing of resources, especially conifers, should be encouraged as a result of these monitoring. The wealth of ethnobotanical knowledge of the resident people should be recorded before it is lost forever.

The Phobjikha valley is now protected as a sanctuary for the cranes. No encroachment by agricultural fields towards the valley is allowed anymore. However, is that enough to protect the endangered crane? Crane foraging behavior needs to be studied to understand diet composition and forage preference. Conservation of a species entails ensuring adequacy of its basic requirements, which in turn, involves protecting the ecosystem that provides for these needs.

Every year, both the cranes and human beings depart, to return again. Both should expect to find their sanctuary in the condition in which they left it.

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Endnotes

¹ This newsletter is an excerpt of a report that I and my national counterpart, Tshewang R. Wangchuk, submitted to the WWF Bhutan Programme and Nature Conservation Section, Forestry Services Division, Royal Government of Bhutan. The opinions expressed in this paper are not views necessarily held by the WWF Bhutan Programme or the Royal Government of Bhutan. Local currency: Nu. 30 = US\$1.00.

 2 The photograph of the cranes below is a WWF photograph reprinted in the *Kuensel* 29 October 1994.

³ A langdo is a local unit of land measurement. For dryland agriculture, a langdo is the amount of land that a farmer with two oxen and can plow in one working day - equivalent to one-third of an acre (The extension agent's handbook 1994).

⁴ A drey, a small wooden container, is a unit of measurement. The drey is based on volume, not on weight. A drey of wheat = approximately 1.56 Kg. A drey of rice paddy = approximately 1.24 Kg (The extension agent's handbook 1994; Dorji 1988).

Species name

Coturnix japonica Ithaginis cruentus Tragopan satyra Dendrocopos hyperythrus Upupa epops Cuculus canorus Hirundapus caudacutus Strix aluco Glaucidium brodiei Caprimulgus indicus Columba hodgsonii Scolopax rusticola Milvus lineatus Accipiter virgatus Spizaetus nipalensis Falco subbuteo Urocissa flavirostris Pyrrhocorax pyrrhocorax Turdus albocinctus Brachypteryx leucophrys Muscisapa sibirica Ficedula strophiata Ficedula superciliaris Niltava sundara Tarsiger indicus Rhyacornis fuliginosus Saxicola ferrea Certhia familiaris Certhia nipalensis Parus rebidiventris Parus ator Parus dichrous Parus monticolus Aegithalos iouschistos Regulus regulus Tesia castaneocoronata Cettia acanthizoides Phylloscopus pulcher Phylloscopus maculipennis Phylloscopus chloronotus Phylloscopus inornatus Phylloscopus magnirostris Seicercus burkii Garrulax leucolophus Garrulax affinis Garrulax erythrocephalus Leiothrix lutea Actinodura nipalensis Minla strigula Minla ignotincta Alcippe vinipectus Yuhina gularis Alauda gulgula Aethopyga nipalensis Passer rutilans Carduelis spinoides Purrhula erythrocephala Mycerobas carnipes Pyrrhoplectes epauletta

Common name

Japanese quail Blood pheasant Satyr tragopan Rufous-bellied woodpecker Eurasian hoopoe Common cuckoo White-throated needletail Tawny owl Collared owlet Grey nightjar Speckled wood-pigeon Eurasian woodcock Black-eared kite Besra Mountain hawk eagle Eurasian hobby Yellow-billed blue magpie Red-billed chough White-collared blackbird Lesser shortwing Dark-sided flycatcher Rufous-gorgeted flycatcher Ultramarine flycatcher Rufous-bellied niltava White-browed bush-robin Plumbeous redstart Grey bushchat Eurasian tree-creeper Rusty-flanked tree-creeper Rufous-vented tit Coal tit Grey-crested tit Green-backed tit Black-browed tit Goldcrest Chestnut-headed tesia Yellowish-bellied bush-warbler Buff-barred warbler Ashy-throated warbler Lemon-rumped warbler Yellowish-browed warbler Large-billed leaf-warbler Golden-speckled warbler White-throated laughingthrush Black-faced laughingthrush Chestnut-crowned laughingthrush **Red-billed** leiothrix Hoary-throated barwing Chestnut-tailed minla Red-tailed minla White-browed fulvetta Stripe-throated vuhina Oriental skylark Green-tailed sunbird Russet sparrow Yellow-breasted greenfinch Red-headed builfinch White-winged grosbeak Gold-naped finch

Habitats

Field, grazing areas and near human settlements Temperate mixed forest Temperate mixed forest Temperate broadleaved, mixed and coniferous forest Fields, grazing areas and human settlements Temperate mixed and conifer forest, fields and grazing area Temperate mixed forest Temperate mixed forest Subtropical broadleaved mixed forest Temperate mixed forest Temperate coniferous forest Temperate mixed and coniferous forest Temperate mixed forest, fields and grazing areas Temperate mixed forest Temperate mixed forest Temperate mixed forest Temperate mixed and coniferous forest Fields, grazing areas and near human settlements Temperate broadleaved, mixed and coniferous forest Temperate broadleaved and mixed forest Temperate braodleaved, mixed and coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate broadleaved and mixed forest Temperate broadleaved and mixed forest Temperate coniferous forest **Rivers** and lakes Fields, grazing areas and near human settlements Temperate mixed forest Temperate mixed forest Temperate mixed and coniferous forest Temperate mixed and coniferous forest Temperate mixed and coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate broadleaved and mixed forest Temperate broadleaved and mixed forest Temperate broadleaved and mixed forest Fields, grazing areas and near human settlements Temperate coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate mixed forest Temperate braodleaved, mixed and coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate broadleaved, mixed and coniferous forest Temperate mixed and coniferous forest Temperate mixed forest Temperate broadleaved and mixed forest Fields, grazing areas and near humann settlements Temperate broadleaved and mixed forest Temperate coniferous forest, fields and grazing areas Fields, grazing areas and near human settlements Temperate mixed forest Temperate mixed and coniferous forest Temperate mixed forest

Appendix II: Plants of ethnobotanical value in the Phobjikha valley

(Local name: D= Dzongkha, N= Nepali; Part used: B= bark, FR = fruits, L= leaves, M= mushroom, MO= moss, R= roots, S= stem/shoot, SD= seed, W= wood; Use: F= fuelwood, M= medicine, W= food wrapper)

Scientific / English name	Local name	Part used	<u>Use</u>
	Dup shamu (D)	Μ	Edible
Jelly fungus	Chiple cheau (N)	Μ	Edible
Trumpet mushroom	Sanai cheau (N)	Μ	Edible
Ear-shaped mushroom	Kaney cheau (N)	Μ	Edible
Needle-shaped mushroom	Suiray cheau (N)	Μ	Edible
	Gopla / Gulphu (N)	FR	Edible
Pine mushroom	Tongphu shamu (D)	Μ	Edible
	Lau shamu (D)	Μ	Bottle corking
	Jambechhu (D)	SD	Edible berry
	Sankar (D)	L	Fodder
	Jathu shing (D)	W	Kitchen utensil
	Humpem (D)	MO	Pillow stuffing
Abies densa	Dung shing (D)	W	F, Incense, Prayer flags
Acer sp	Wanka (D)	W	F
Amaranthus sp	Zhimtsi (D)	SD	Edible
Arundinaria maling	Higtsa (D)	S	Fodder
Berberis sp	Kepi tsang (D)	FR	Edible
Betula utilis	Tap shing (D)	W	F
Daphne sp	Dhay (D)	В	Paper/statue making
Elaeagnus parvifolia	Bji (D)	FR	Edible
Elsholtzia fruticosa	Theykom (D)	L	Doma substitute, floor polish
Fragaria sp	Riga tchelu (D)	FR	Edible
Juniperus sp	Shup shing (D)	W, L	Prayer flags, Incense
Lycopodium olabatum	Oochum (D)	MO	Scrubber
Pinus wallichiana	Tongphu shing (D)	W	F, Timber, Prayer flags
Potentilla sp	Jokosithey (D)	R	Doma substitute
Pteridium aquilinum	Kem (D)	Fern	Green manure, bedding
Rhododendron sp	Khem (D)	W	F, Incense
Rosa sp	Siu shing (D)	В	Doma substitute
Rubus ellpticus	Tongphu thelu (D)	FR	Edible berry
Swertia ciliata	Mashom (D)	L	Fever M; W