

## **Use of Forest Resources by Residents of Jigme Singye Wangchuck National Park, Bhutan**

Authors: Katel, Om N., and Schmidt-Vogt, Dietrich

Source: Mountain Research and Development, 31(4) : 325-333

Published By: International Mountain Society

URL: <https://doi.org/10.1659/MRD-JOURNAL-D-10-00077.1>

---

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](http://www.bioone.org/terms-of-use).

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

# Use of Forest Resources by Residents of Jigme Singye Wangchuck National Park, Bhutan

## Practices and Perceptions in a Context of Constraints

Om N. Kate<sup>1</sup>\* and Dietrich Schmidt-Vogt<sup>2</sup>

\* Corresponding author: kateombhutan@yahoo.com

<sup>1</sup> Natural Resources Management, School of Environment Resources and Development, Asian Institute of Technology, Thailand

<sup>2</sup> Centre for Mountain Ecosystem Studies, Kunming Institute of Botany, Chinese Academy of Sciences, Heilongtan, Kunming 650204, China

Open access article: please credit the authors and the full source.



*This paper examines the use of forest resources by local residents in Jigme Singye Wangchuck National Park, Bhutan. It also inquires into local residents' knowledge and perceptions of park management interventions. The data*

*were collected through a questionnaire survey, group*

*discussions, and observations. The results show that local people depend on forest resources for their livelihoods, and that their knowledge and perceptions of the park and of park management are influenced mainly by constraints on their access to forest resources, and by benefits and incentives obtained from the park administration through socioeconomic development.*

**Keywords:** Forest resource use; management; perceptions; protected area; buffer zone; Bhutan.

**Peer-reviewed:** July 2011 **Accepted:** September 2011

## Introduction

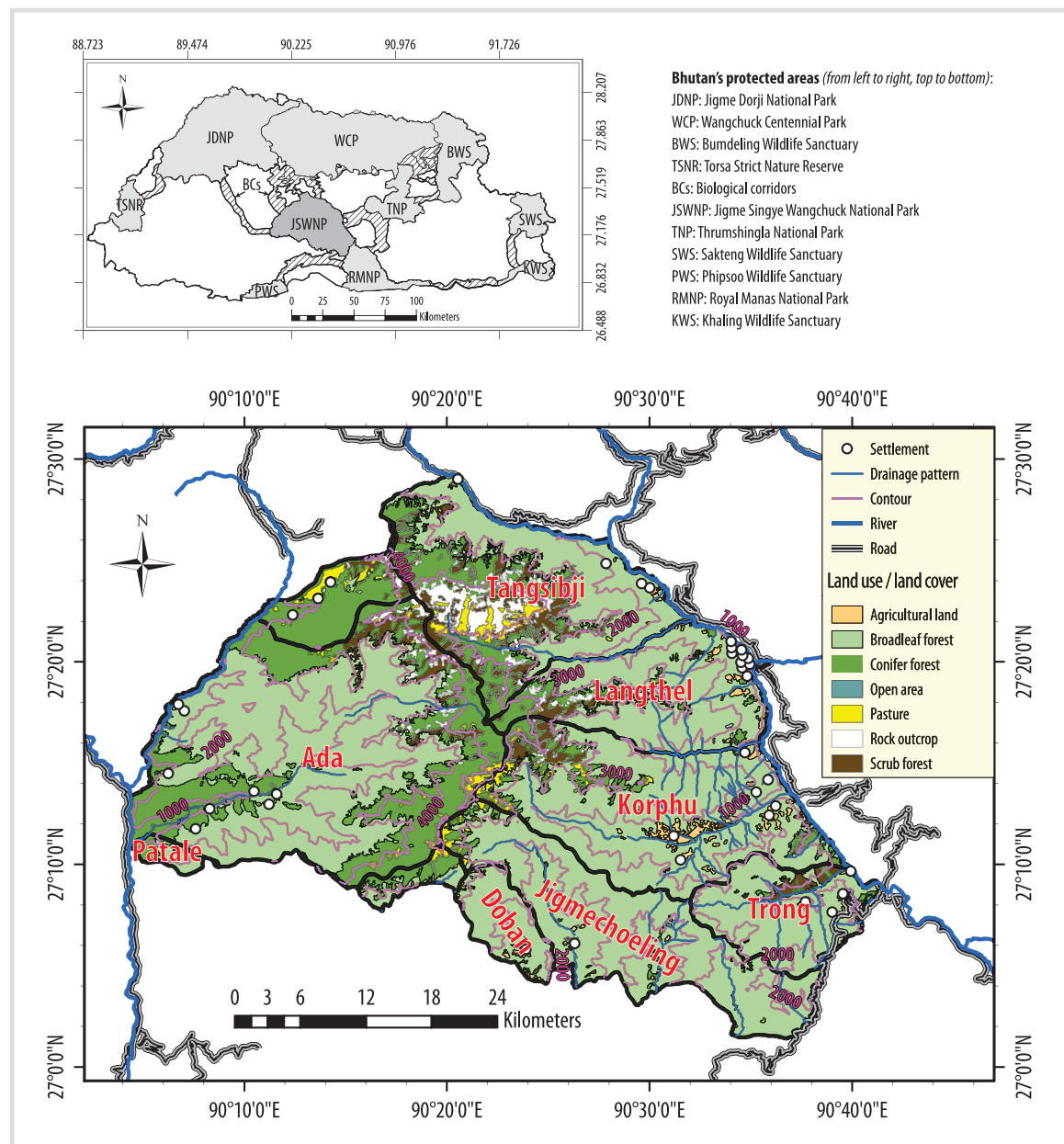
Protected areas (PAs) around the world are considered effective means for conserving biodiversity. However, the effectiveness of PAs can be impaired by policies that are not consistent with the interests of local communities (Wallner et al 2007). Since almost all drivers affecting biodiversity conservation are of socioeconomic origin (Sodhi et al 2004), PA management should address such issues, including those related to access to forest resources. Limited access to forest resources, on the other hand, has a negative bearing on rural people's livelihoods, which ultimately affects their perceptions of PAs and conservation policy (Brown 1998; Müller-Böker and Kollmair 2000). Farmers, who make up 69% of Bhutan's population, depend directly on natural resources, including forests (RGOB 2002). The emphasis of conservation policy according to the constitution of Bhutan, however, is on maintaining a minimum of 60% of the total land area under forest cover (RGOB 2002) as habitat for wildlife, especially mammals, and on curbing the growing pressure on forests, which is arising from the country's expanding human population (RGOB 2004). Improving the welfare and livelihood of people is another important aspect of the constitution of Bhutan, for which the change of Bhutan to a democratic form of government in 2008 provides further scope.

Conservation policies still reflect the "fortress conservation" model according to Galvin and Haller (2008), which was applied when conservation in Bhutan started in the 1960s (RGOB 2008). Conservation in

Bhutan has been termed a success mainly because of the rapid increase in the total land area under PA management that occurred between 1999 (35%) and 2008 (51%). Parks, however, were established based on biological considerations only, with little or no regard for the needs of local communities (Seeland 2000). Though Bhutan's park policies allow residents to remain inside PAs (Wang et al 2006a), they restrict their access to forests at the same time and expose them to dangers emanating from forests (Wang et al 2006a, 2006b). The impact on local populations of giving such a large extent of forestland PA status and its effect on their perceptions of conservation have not yet been studied in Bhutan.

This paper addresses this knowledge gap by examining forest resources use by local residents in Jigme Singye Wangchuck National Park (JSWNP) and how their perceptions are shaped by their dependence on the forest and by park management interventions. JSWNP was selected for this research, as it is a flagship area for conservation owing to its location, geographical variations, and heterogeneous communities (RGOB 2004; Wang et al 2006a). JSWNP was demarcated in 1993 and gazetted in 1995 in a top-down process that left local people out of the designation procedure. Past research in JSWNP primarily addressed human-wildlife conflicts and the attitudes of the local people concerning this problem (Wang and Macdonald 2006; Wang et al 2006a, 2006b). This paper is the first of its kind to examine forest resources use by residents inside a Bhutan PA. The overall objectives of this study are to explore farmers' use of land and forest resources, to analyze local people's awareness

**FIGURE 1** Map of Protected Areas and JSWNP. (Map by Om Katel, based on data obtained from the Wildlife Conservation Division [WCD], Department of Forests and Park Services)



of park establishment and of the park's significance for conservation, to examine locals' perception of management, and to identify constraints on local livelihoods due to conservation rules and regulations.

## Methods

### Study area

The study area is located in central Bhutan (Figure 1) between 27°13'N and 90°24'E, with altitudes ranging from 200 to 5000 masl. JSWNP is the third largest national park in Bhutan and covers an area of 1723 km<sup>2</sup> spread over 5

dzongkhags (districts) and 11 gewogs (subdistricts). The park is located within the Inner Himalaya, an area of transition between the monsoon-exposed southern and the dry, cold northern side of the Himalayas (Ohsawa 1987). About 6000 people live on small farms scattered inside the park and along the park's boundaries (see Table 1 for demographic characteristics). Local people in JSWNP belong to the Ngalo, Kheng, Sharchop, Mangdeep, Monpa, and Lhotshamp ethnic groups. The local residents are primarily agro-pastoralists and have no or very limited nonfarm employment opportunities (Wang et al 2006a, 2006b).

**TABLE 1** Demographic characteristics in the study area (percentages in parentheses).

Characteristics	Inner area	Buffer area
<b>Gender</b>		
Female	43 (50)	91 (51)
Male	43 (50)	87 (49)
<b>Age</b>		
<40	47 (54.7)	87 (48.9)
≥40	39 (45.3)	91 (51.1)
<b>Marital status</b>		
Married	79 (91.9)	158 (88.8)
Unmarried	7 (7.1)	20 (11.2)
<b>Education level</b>		
Literate	9 (10.5)	33 (18.5)
Illiterate	77 (89.5)	145 (81.5)
<b>Livestock holdings</b>		
<11	47 (54.7)	87 (48.9)
≥11	39 (45.3)	91 (51.1)
<b>Family size</b>		
<7	54 (62.8)	108 (60.7)
≥7	32 (37.2)	70 (39.3)
<b>Religion</b>		
Hindu	0 (0)	57 (32.2)
Buddhist	86 (100)	120 (67.8)
<b>Total</b>	<b>86</b>	<b>178</b>

### Data collection and analysis

This research was conducted from June to November 2008 in 8 of 11 *gewogs*, chosen because they are situated below the timberline, except 1 *gewog* that does not have any settlements. We classified the 8 selected *gewogs* as being either inner zone (Ada, Korphu, and Doban) or buffer zone (Tangsibji, Langthel, Trong, Jigmechhoeling, and Patale) based on the travel distance to the nearest road points. People living in the buffer areas have direct access to roads or are less than 3 hours away from a road, whereas residents of the inner areas travel more than 3 hours on foot to reach the nearest road.

The underlying hypothesis for this research is that local people's perception of PAs depends on perceived costs and benefits, on how PA management affects their livelihoods, and on their knowledge about PA management. As most of these factors are quantifiable, a statistical approach was used. The results of this study are expected to offer a systematic way to identify factors that

park managers need to address in order to improve conservation of natural resources by fostering positive perceptions among local people living in and around PAs.

Research was carried out by means of pretested semistructured questionnaires with structured as well as open-ended questions on perceptions of park value and management, and on forest resources use and constraints. The questionnaires were supplemented with informal meetings, discussions, and participatory appraisal of people's activities (see Table 1 for sample size). A team of 4 researchers conducted the survey. Interviews were held by the researchers without the aid of translators, as most local people could speak the national language, Dzongkha. In addition, members of the research team were fluent in local dialects: Sharchopka, Khengkha, and Lhotshamkha.

We asked open-ended as well as semistructured questions to elicit residents' patterns of forest resources use, their knowledge of park establishment and its

**TABLE 2** Respondents' landholdings and corresponding land-use categories.

Land use in percent of responses <sup>a)</sup>	Inner area		Buffer area	
	Owned (%)	Leased (%)	Owned (%)	Leased (%)
<i>Chhuzhing</i> (83%)	96.3	3.7	92.7	7.3
<i>Kamzhing</i> (91.3%)	98.7	1.3	97.0	3.0
<i>Tseri</i> (39.8%)	96.7	3.3	97.3	2.7
<i>Tsamdro</i> (20.5%)	91.7	–	90.5	9.5
<i>Sokshing</i> (17.0%)	95.5	–	91.3	–
Mandarin orchard (15.5%)	9.5	–	90.5	–
Cardamom (5.3%)	5.3	–	–	–

<sup>a)</sup>For both inner and buffer areas ( $N = 264$ ).

boundaries, residents' compliance with rules on forest resources use, and their perception of JSWNP. Data collected through the household questionnaire survey were analyzed using SPSS version 16. The categorical demographical variables were transformed into dichotomous variables and entered into logistic regression. Forest resources use and access and land-use types were all summarized by descriptive statistics. For logistic regression, all the three-, four-, or five-point scales were collapsed to form dichotomous responses based on the negative and positive point scales. The result is provided with odds ratios. Such collapsing into only 2 results leads to a loss of information but is considered the best way to carry out this analysis because variables with logistic regression can help to explain why some respondents are more favorably inclined toward conservation in the park than others (Field 2009). Logistic regression was used to determine whether variables such as gender, age, education, household size, marital status, location of settlement, and religion influence respondents' perceptions. The Wald statistics in logistic regression can be used to determine whether a variable is a significant predictor of the outcome as it can show whether the  $b$ -coefficient for a given predictor is significantly different from zero. It helps to determine whether the predictor is a significant contributor toward the outcome.

## Results and discussion

### Land use in JSWNP

Subsistence agriculture is the main livelihood activity in JSWNP and is practiced in the following land use categories: *chhuzhing* (irrigated land), *kamzhing* (dry land), *tseri* (shifting cultivation), *sokshing* (public woodlots, with individuals or communities having user rights to leaf litter, fodder, and firewood), *tsamdro* (natural pasture over which residents have grazing rights), and orchards and cardamom gardens. Results show that *kamzhing* and *chhuzhing* are widespread in JSWNP and that most

residents own the land (Table 2). The landholdings are significantly smaller, and more people have leased land for farming in the inner areas than in the buffer areas ( $P < 0.05$ ). *Tseri* is still a prominent land use (Table 2; Figure 2). It had been practiced by 38.9% of respondents before it was banned in 1995 (RGOB 2007), and 24.6% were still practicing it despite the ban, mainly for lack of better alternatives. Most of the respondents who discontinued *tseri* did so because they received some form of incentives such as corrugated galvanized iron (CGI) sheets and solar lighting.

### Patterns of forest resources use

Forest resources use is closely linked to subsistence farming. The 4 most important uses of the forest in JSWNP are grazing, shifting cultivation, collection of fuelwood, and leaf litter. Fuelwood appears to be the main source of energy as only a few households had access to electricity in the buffer area, and none in the inner area, until the end of 2008 (Table 3). Fuelwood is used for heating and cooking purposes. Trees to be felled are

**FIGURE 2** Shifting cultivation (*tseri*) landscape as seen from Nabji village. *Tseri* remains an important form of farming in some park areas despite the ban imposed in 1995. (Photo by Om Katel)



**TABLE 3** Forest product use as ranked by park residents.<sup>a)</sup>

Forest product use ranking	Responses (%)	
	Inner area	Buffer area
Fuelwood	100.0	96.1
Timber	73.3	94.4
Leaf litter and fodder	84.9	76.4
Medicinal plants	69.8	23.6
Weaving and basketry	37.2	16.3
Tool handles	33.7	1.7
Poles for fencing and prayer flags	3.5	14.6
Thatch materials	10.5	1.1

<sup>a)</sup>Total responses > 264 ( $N = 264$ ) because multiple answers were recorded.

hammer-marked by officials after the residents have obtained written permission. *Castanopsis* is the most important fuelwood species in both inner and buffer areas (Table 4).

In terms of rules constraining forest resources use, inner area residents were more concerned than buffer zone residents about harvesting non-timber forest products (NTFPs), which supplement the livelihoods of park residents (Table 5), while buffer area residents were more concerned about livestock grazing because livestock are a significant source of income. Similar findings on the importance of fuelwood, leaf litter, and timber have also been reported from Bardia National Park and Sukla Phanta Wildlife Reserve in western Nepal (Heinen and Baral 2007).

Livestock are usually kept at home during winter and midsummer. When the fields are cultivated, herds are taken to the forest. When fodder is scarce, livestock are fed by lopping leaf fodder from trees. Fodder trees are planted at the edges of farmlands mostly in villages of the buffer areas. Trees are planted and coppiced. In inner areas, fodder is mostly harvested from the forest. We saw no planted fodder trees. *Ficus oligodon*, *Ficus nemoralis*, *Ficus hookerii*, *Ficus semicordata*, and *Celtis tetranda* are commonly used fodder species in Doban, Jigmechoeling, and Patale

while *Quercus griffithii* is commonly used in Ada, Tangsibji, and Langthel. Leaf litter of nonfodder species such as *Pinus roxburghii* can be used for cattle bedding, and ultimately as organic manure.

#### Local people's knowledge about JSWNP and park boundaries

About 80% of the respondents were aware that JSWNP had been established about 15 years earlier (87.2% in inner areas and 76.4% in buffer areas). Logistic regression (Supplemental data, Table S1; <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.S1>) revealed that knowledge regarding park establishment was more likely to be associated with males ( $P < 0.01$ ), incentive recipients ( $P < 0.01$ ), large family size ( $P < 0.01$ ), and greater livestock holding ( $P < 0.05$ ). Fewer people knew about the main boundary of JSWNP (41.9% in inner areas and 46.6% in buffer areas). Gender ( $P < 0.05$ ), education ( $P < 0.01$ ), and family size ( $P < 0.01$ ) were significant predictors associated with knowledge about borders (Supplemental data, Table S1; <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.S1>). We found no significant differences, however, between inner and buffer areas in terms of knowledge about park boundaries. Similar observations were made in Royal Bardia National Park in Nepal (Allendorf et al 2007).

**TABLE 4** Species used for fuelwood.

Gewog	Tree species
Jigmechoeling and Doban	<i>Alnus nepalensis</i> , <i>Macaranga denticulata</i> , <i>M. pustulata</i> , <i>Schima wallichii</i> , <i>Callicarpa arborea</i> , <i>Castanopsis hystrix</i> , <i>C. tribuloides</i>
Ada and Patale	<i>Pinus roxburghii</i> , <i>Castanopsis tribuloides</i> , <i>Quercus griffithii</i> , <i>Lithocarpus elegans</i> , <i>Schima wallichii</i>
Korphu and Trong	<i>Castanopsis tribuloides</i> , <i>C. hystrix</i> , <i>Altingia excelsa</i> , <i>Schima wallichii</i>
Langthel and Tangsibji	<i>Quercus griffithii</i> , <i>Castanopsis hystrix</i>

**TABLE 5** Species used as NTFPs.

Species used as NTFPs	Purpose
Tender shoots of <i>Calamus flagellum</i> , <i>Dryopteris</i> spp, <i>Elastostemma</i> spp	Vegetables
<i>Rhus</i> spp, <i>Strobilanthes</i> spp, <i>Rubia</i> spp, <i>Prunus</i> spp	Dyes
<i>Calamus</i> spp, <i>Bambusa tulda</i> , <i>B. alarnii</i> , <i>B. clavata</i>	Weaving and basketry
<i>Pinus roxburghii</i> , <i>Castanopsis hystrix</i> , <i>Ficus cordata</i> , <i>Bambusa</i> spp, <i>Musa</i> spp, <i>Oroxylum indicum</i> , <i>Rhus</i> spp, <i>Cymbopogon</i> spp, <i>Artemisia vulgaris</i> , <i>Quercus</i> spp	Religious and cultural
<i>Bombax ceiba</i> , <i>Phyllanthus emblica</i> , <i>Artemisia vulgaris</i> , <i>Terminalia chebula</i> , <i>Rubia cordifolia</i> , <i>Zanthoxylum</i> spp, <i>Adhatoda vasica</i> , <i>Erythrina arborescence</i>	Medicinal
<i>Toddalia</i> spp, <i>Gynocardia</i> spp, <i>Aesandra</i> spp	Edible oil

The finding that families with more than 7 members were more aware of the park than smaller families could be due to the fact that more members in a household means more opportunities for interaction outside the home, including participation in awareness programs.

Those aware of the park were also more likely to complain about constraints (Figure 3). Inner area residents complain more about restrictions on NTFP harvests and sales, while buffer area residents complain more about loss of ownership rights regarding the forest resources. Recognition of ownership of forest resources was found to enhance the conservation of resources in Bardia National Park and Sukla Phanta Wildlife Reserve in Nepal (Heinen and Baral 2007).

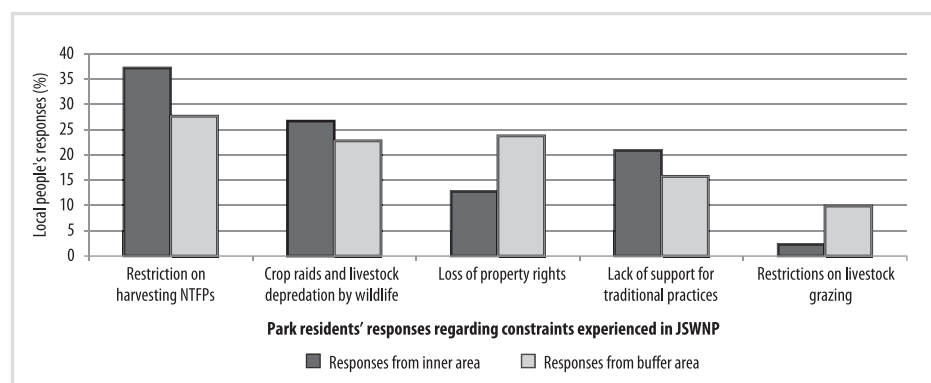
### Compliance with rules on resources harvest

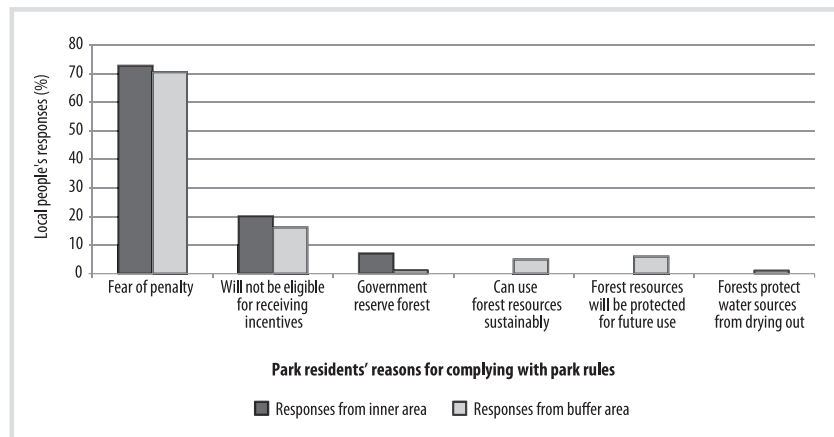
The majority of respondents were found to be aware of forest resources harvest rules (93.0% in inner areas and 74.3% in buffer areas) and to agree with them (84.3% in inner areas and 78.2% in buffer areas). Rules are guided by the 1995 Forest and Nature Conservation Acts of Bhutan. Respondents complying with rules are recipients of incentives ( $P < 0.05$ ) and Buddhists ( $P < 0.01$ ), but there were no significant differences between inner and

buffer areas (Supplemental data, Table S1; <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.S1>).

Financial compensation for the depredation of crops and livestock in the park was introduced in 2002 and withdrawn in 2006 because of shrinking support from donor agencies (personal communication, Mani Sangye, Park Manager, 2008). However, attitudes appear to be favorable toward conservation when economic benefits are provided to park residents, as reported from Wolong Biosphere Reserve, China (Xu et al 2006), and from Annapurna Conservation Area (ACA) and Makalu-Barun Conservation Area (MCA) in Nepal (Mehta and Heinen 2001).

Park management decisions are usually made at the national level and passed on to the local level, which is typical for the “fortress conservation” model that is practiced in Bhutan. There is evidence that the willingness of the majority of respondents to comply with park rules is due to strict enforcement by park management (Figure 4). Evidence from ACA and MCA in Nepal (Mehta and Heinen 2001) and from Yunnan in China (Zhou and Grumbine 2011) showed that a participatory approach can be more successful than the top-down approach in terms of improving local people’s livelihoods and their attitude toward conservation.

**FIGURE 3** Park residents’ responses on constraints experienced in JSWNP.

**FIGURE 4** Park residents' reasons for complying with park rules.

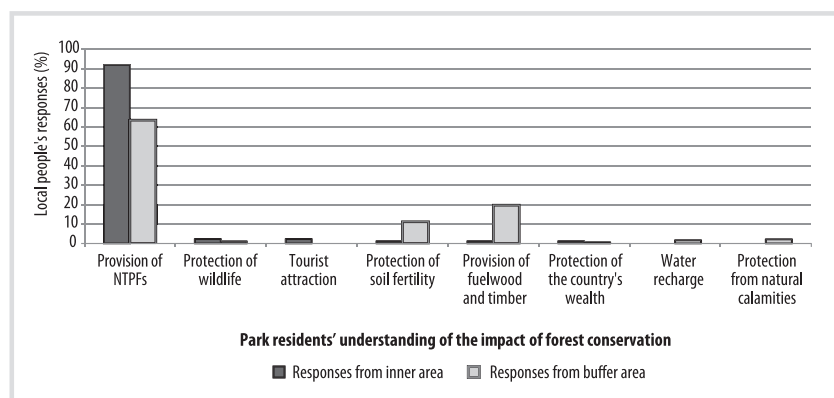
### Local people's perception of forests and of JSWNP

The majority of respondents (77.4%) found forests important as a source of NTFPs but also acknowledged the significance of their ecological functions (Figure 5). The relevance of the park for conservation was assessed by asking respondents whether the park played an important role in protecting forests and wildlife species. While the park was perceived by 11.7% as very important in this respect, and by 23.9% as important, the other respondents associated the park with constraints to their livelihoods.

Results (*Supplemental data*, Table S1; <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.S1>) revealed that men were 4 times more likely than women to perceive the park as important ( $P < 0.01$ ), Buddhists 3 times more likely than Hindus ( $P < 0.05$ ), families with fewer than 7 members 2 times more likely than bigger families ( $P < 0.05$ ), and respondents with smaller livestock holdings were 3 times more likely to consider the park important for conservation ( $P < 0.01$ ). No significant differences were found between responses given in the inner and buffer areas, respectively.

Respondents aware of the park and convinced of its importance were more likely to be male, which could be due to the fact that men have more time and more opportunities to interact socially and acquire information than women, who are busy with household work. This is consistent with the findings of Xu et al (2006) in Wolong Biosphere Reserve, China.

Buddhists perceive the park as more important than Hindus and are also more likely to comply with park rules. This cannot be simply attributed to culture as both Buddhists and Hindus believe that certain deities are manifested in the natural environment, and that certain parts of the natural environment should be protected for religious reasons, such as sacred groves (Ingles 1997). It is noteworthy that in JSWNP, sacred groves are found only in the inner area, where all respondents were Buddhists, whereas none are found in the buffer areas, where Hindus reside. The differences between Buddhists and Hindus are more likely to be associated with the minority status of Hindus in Bhutan, where Buddhism is the state religion. However, more research is required on the relation

**FIGURE 5** Park residents' understanding of the impact of forest conservation.

between religious beliefs and conservation of forests in Bhutan.

Families with fewer than 7 members perceive the park as important mainly because smaller families are eligible to receive incentives such as CGI sheets. Another reason for the favorable perception of the park by smaller families with smaller herds could be that they require fewer forest resources than households with larger herds. Residents with more livestock were particularly worried that park boundaries might entail additional restrictions on fodder collection and more risks toward depredation of livestock by wildlife. This confirms the findings of Wang et al (2006b) showing that residents with more livestock were opposed to conservation-related restrictions.

Proper resources management is negatively affected by herds migrating into the park from outside, excessive harvesting of fodder as livestock feed, and illegal felling of trees for cash income from timber sale. Evidence for these illegal practices were chain saws and tree felling observed by the research team. An additional reason for illegal harvesting of forest resources were administrative obstacles. One of the respondents mentioned that “to obtain permits requires a long waiting time and we usually miss the season to harvest forest resources. For this reason some residents prefer to harvest illegally, although the risk of being fined heavily is high.” This is, however, not common as most residents agree with conservation rules. We also found that only 47.9% of respondents had sought permits in the past 15 years.

## Conclusions and recommendations

The findings of this study confirm that forest resources are of vital importance for park residents, and that access to forests has a strong influence on how they perceive the park and park management rules. Park residents are dependent on forest resources to such an extent that restrictions on access negatively affect their livelihoods. Residents who are exposed to wildlife threats would also perceive the park as a source of problems. They request that their traditional system of farming should be recognized and access to forest resources improved. They are also, on the whole, more interested in compensation schemes and developmental programs than in

conservation. Conflicts between the park authorities and local people can be traced back to dissatisfaction with incentives and downscaling of development support due to declining and limited funds levels. But even an improved incentive scheme would not necessarily mean that the attitude of local people toward conservation would become more positive. There is an underlying lack of trust and cooperation between the park authorities and the local population, as suggested by the finding that people comply with management rules primarily out of fear that park management may fine them heavily and only secondarily because they are convinced of the necessity and validity of these rules.

Our comparison of inner and buffer areas yielded no significant differences in terms of knowledge about the park, compliance with park rules, and perception of park management. An exception is the ranking of forest use in terms of daily needs. Park residents feel frustrated with management practices, which points strongly toward serious gaps in communication and cooperation between park management and local residents. Lack of communication also explains why park residents are not clear about who is eligible to harvest which types of resources. Informing park residents more effectively would create an environment conducive to conservation in JSWNP, and would help to avoid resources use conflicts among park residents and between park residents and people from outside the park. Park management should focus on women, who are less aware of the park than men, as well as large families and households with large livestock holdings who are more concerned about constraints than other families.

The findings of this study may come as a surprise to those who have been impressed by the sheer spatial extent of conservation activities in Bhutan. The extensive area assigned for conservation purposes is the main reason why conservation is dubbed successful, though this success comes at the cost of local people. Current park policies at JSWNP can be criticized for not supporting traditional resources management and thus alienating park residents, who feel that their livelihood concerns are not sufficiently taken into account. Modifying policies and improving communication would thus certainly help to ensure that the commendable goal of conserving extensive forest areas in Bhutan can be achieved with support from the local population.

## ACKNOWLEDGMENTS

This research was supported by the Norwegian Ministry of Foreign Affairs through the Asian Institute of Technology, Thailand, and the John D. and Catherine T. MacArthur Foundation through Professor Jill M. Belsky and Professor Stephen F. Siebert, University of Montana, USA. The authors would like to thank Dr Edward L. Webb, National University of Singapore, for his comments during the initial preparation of this manuscript and Dr Terje

Gobakken, Norwegian University of Biological Sciences, for providing the necessary help in generating maps. We would like to thank Mr Mewang Dorji, Mr Lungten Tshewang, Mr Sonam Wangchuk, Mr Raj Ghalley, Mr Sonam, and Mr Jigme Jamtsho for assistance during fieldwork. Finally, sincere thanks go to 2 reviewers, whose very useful suggestions greatly helped in improving the original manuscript.

## REFERENCES

- Allendorf TD, Smith JLD, Anderson DH.** 2007. Residents' perceptions of Royal Bardia National Park, Nepal. *Landscape and Urban Planning* 82:33–40.
- Brown K.** 1998. The political ecology of biodiversity, conservation and development in Nepal's Terai: Confused meanings, means and ends. *Ecological Economics* 24:73–87.
- Field AP.** 2009. *Discovering Statistics Using SPSS*. 3rd edition. London, UK: Sage.
- Galvin M, Haller T, editors.** 2008. *People, Protected Areas and Global Change: Participatory Conservation in Latin America, Africa, Asia and Europe*. Perspectives of the Swiss National Centre of Competence in Research (NCCR) North-South, University of Bern, Vol. 3. Bern, Switzerland: Geographica Bernensia.
- Heinen JT, Baral N.** 2007. Resource use, conservation attitudes, management intervention and park-people relations in the western Terai landscape of Nepal. *Environmental Conservation* 30:1–9.
- Ingles AW.** 1997. The influence of religious beliefs and rituals on forest conservation in Nepal. In: Seeland K, editor. *Nature Is Culture: Indigenous Knowledge and Socio-cultural Aspects of Trees and Forests in Non-European Cultures*. Exeter, UK: Intermediate Technology Publications, pp 57–66.
- Mehta JN, Heinen JT.** 2001. Does community-based conservation shape favorable attitudes among locals? An empirical study from Nepal. *Environmental Management* 28(2):165–177.
- Müller-Böker U, Kollmair M.** 2000. Livelihood Strategies and Local Perceptions of a New Nature Conservation Project in Nepal. *Mountain Research and Development* 20(4):324–331.
- Ohsawa M.** 1987. *Life Zone Ecology of Bhutan Himalaya*. Chiba, Japan: Laboratory of Ecology, Chiba University Press.
- RGOB [Royal Government of Bhutan].** 2002. *Biodiversity Action Plan*. Thimphu, Bhutan: Ministry of Agriculture.
- RGOB [Royal Government of Bhutan].** 2004. *Bhutan Biological Conservation Complex*. Thimphu, Bhutan: Nature Conservation Division, Department of Forestry Services, Ministry of Agriculture, with support from WWF Bhutan Program.
- RGOB [Royal Government of Bhutan].** 2007. *Land Act of Bhutan*. Thimphu, Bhutan: Department of Survey and Land Records.
- RGOB [Royal Government of Bhutan].** 2008. *The Constitution of the Kingdom of Bhutan*. Thimphu, Bhutan: ROGB.
- Seeland K.** 2000. National Park Policy and Wildlife Problems in Nepal and Bhutan. *Population and Environment* 22(1):43–62.
- Sodhi NS, Koh LP, Brook BW, Ng PKL.** 2004. Southeast Asian biodiversity: An impending disaster. *TRENDS in Ecology and Evolution* 19(12):654–660.
- Wallner A, Bauer N, Hunziker M.** 2007. Perceptions and evaluations of biosphere reserves by local residents in Switzerland and Ukraine. *Landscape and Urban Planning* 83(2–3):104–114.
- Wang SW, Curtis PD, Lassoie JP.** 2006a. Perceptions of the grass root farmers on crop damage by wildlife in the Jigme Singye Wangchuck National Park. *Bulletin of the Wildlife Society* 34(2):359–365.
- Wang SW, Lassoie JP, Curtis PD.** 2006b. Farmers' attitudes toward conservation in Jigme Singye Wangchuck National Park, Bhutan. *Environmental Conservation* 33(2):148–156.
- Wang SW, Macdonald DW.** 2006. Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. *Biological Conservation* 129:558–565.
- Xu J, Chen L, Lu Y, Fu B.** 2006. Local people's perceptions as decision support for protected area management in Wolong Biosphere Reserve, China. *Journal of Environmental Management* 78:362–372.
- Zhou DQ, Grumbine RE.** 2011. National Parks in China: Experiments with protecting nature and human livelihoods in Yunnan province, People's Republic of China. *Biological Conservation* 144:1314–1321.

## Supplemental data

**TABLE S1** Results of logistic regression showing the effects of demographic and socioeconomic factors on park knowledge and management.

Found at DOI: <http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00077.S1> (49.8 KB PDF).