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Effectiveness of community involvement in delivering conservation benefits to the Annapurna Conservation Area, Nepal

SIDDHARTHA B. BAJRACHARYA[1,2], PETER A. FURLEY[2] AND ADRIAN C. NEWTON[3]*

[1]*King Mahendra Trust for Nature Conservation, PO Box 3712 Kathmandu, Nepal,* [2]*Institute of Geography, School of Geosciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, UK, and* [3]*School of Conservation Sciences, Bournemouth University, Talbot Campus, Poole, Dorset BH12 5BB, UK*

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SUMMARY

Community-based approaches to decision-making in the management of protected areas are increasingly being implemented in many areas. However information on the outcome of these approaches for conservation is often lacking. In this study, the effectiveness of community-based approaches for conservation of biodiversity was examined in Annapurna Conservation Area (ACA) (Nepal) through a combination of ecological assessments and social surveys undertaken both within and outwith ACA. Forest basal area and tree species diversity were found to be significantly higher inside ACA than in neighbouring areas outside. The mean density of cut tree stumps was significantly lower inside ACA, associated with a decline in use of fuelwood as an energy source over the past decade. Social surveys also indicated that wild animal populations have increased inside ACA since the inception of community-based conservation. Observations of animal track counts, pellet counts and direct observations of selected species such as barking deer (*Muntiacus muntjak*) and Himalayan tahr (*Hemitragus jemlahicus*) indicated higher abundances within ACA. The community-based management has been successful in delivering conservation benefits in ACA, attributable to changing patterns of resource use and behaviour among local communities, increased control of local communities over their local resources, increased conservation awareness among local people resulting from environmental education, and the development and strengthening of local institutions such as Conservation Area Management Committees (CAMC). However, these positive achievements are threatened by the current political instability in Nepal.

Keywords: biodiversity, community, conservation, forest, Nepal, protected area

* Correspondence: Dr Adrian Newton Tel: +44 (0)1202 595670 Fax: +44 (0)1202 595255 e-mail: anewton@bournemouth.ac.uk

INTRODUCTION

Protected areas (PAs) are a central component of conservation strategies throughout the world, and represent the single most important method of conserving biodiversity (Wells & Brandon 1992). Over the past 20 years, it has become widely recognized that the management of PAs should include the cooperation and support of local communities (Wells & Brandon 1992). This has encouraged the development of 'community-based conservation' (Mehta & Kellert 1998), which emphasizes the role of local communities in decision-making (Adams & Hulme 1998). According to this approach, local communities should be active partners in PA management (Songorwa *et al*. 2000).

Community-based conservation projects have now been initiated in many countries, most notably in Africa, and have contributed to decreases in poaching, improved conservation through increase in wildlife game scouts and direct economic benefits from trophy hunting (Metcalfe 1994; Lewis & Alpert 1997; Wainwright & Wehrmeyer 1998). However, there are growing concerns that such schemes have succeeded in protecting some of the larger mammals not by their ability to distribute socioeconomic benefits, but by virtue of their increased enforcement levels (Gibson & Marks 1995). In some cases there has been no decrease in wildlife poaching rate compared to the situation before inception of the programmes, although the poachers have shifted their tactics and prey selection (Gibson & Marks 1995). Also, some have argued that this conservation approach promotes a utilitarian, economic approach to conservation at the expense of scientific, ethical and aesthetic considerations (Schaik & Rijksen 2002).

Unambiguously successful examples where the development needs of local people have been effectively reconciled with biodiversity conservation remain difficult to find (Wells 1995). Evidence that community-based conservation has benefited conservation is often indirect at best (Lewis & Alpert 1997). Some critics of community-based approaches have argued for renewed emphasis on authoritarian enforcement of PAs to safeguard critically-threatened habitats and species (Terborgh 1999; Wilshusen *et al*. 2002). The question therefore remains as to whether the community-based approach really is effective in delivering conservation benefits.

In Nepal, most PAs have been established following a strict protectionist approach with the armed forces controlling any illegal activities. Despite some success achieved in protection of certain flagship species, a number of problems have emerged, including displacement of local communities, poaching of protected species, and confrontation between PA guards and local communities (McLean & Straede 2003). To address these problems, the Nepal government has over the past two decades introduced community-based approaches to PA management. An example is provided by Annapurna Conservation Area (ACA), where local communities are involved in conservation planning and management while being able to continue their traditional land-use practices (KMTNC-ACAP [King Mahendra Trust for Nature Conservation-Annapurna Conservation Area Project] 1997, 2001). Despite the success of ACA in delivering benefits to local communities, the conservation benefits of community-based conservation initiatives in Nepal, including ACA, have been little researched (Heinen & Mehta 1999; Kellert *et al.* 2000; Nepal 2002).

The aim of this research was to critically examine whether or not the community-based approach to ACA management is successful in delivering conservation benefits in terms of improved biodiversity status. This was achieved through a combination of ecological and social surveys undertaken both within and outside ACA, enabling areas under community-based management to be compared with adjacent areas under traditional forms of land use.

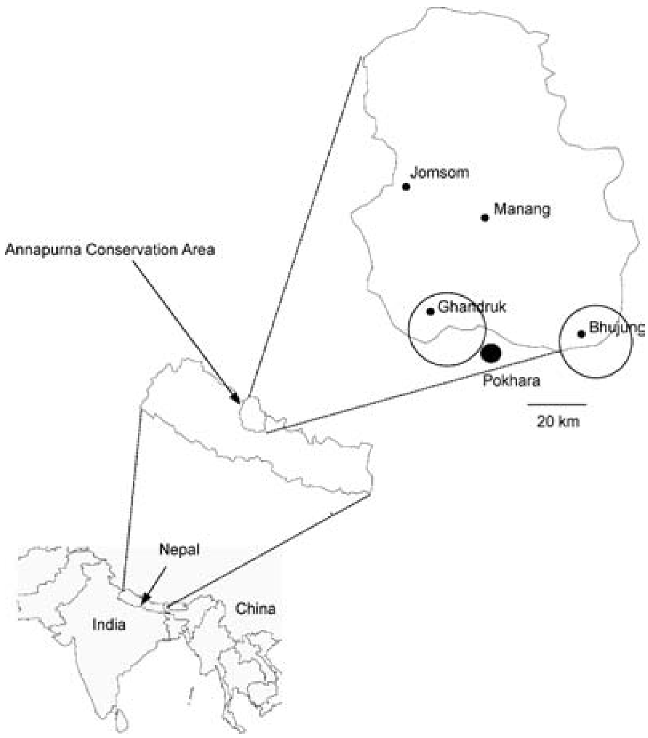

Figure 1 Location of the Annapurna Conservation Area. The study sites surrounded the villages of Ghandruk (Kaski district) and Bhujung (Lamjung district).

METHODS

Study area

The ACA is the largest PA in Nepal, covering 7629 km^2, located in the mountainous west-central region (83°57′E, 28°50′N). ACA is well known internationally for its outstanding scenic beauty, unique ecology and rich cultural heritage. Some of the world's highest mountains and the world's deepest river valley lie within ACA. The geology, physiography and climate vary markedly across ACA, owing to the high altitudinal range and dissected topography, providing a wide range of different habitats. More than 472 bird species, 21 species of amphibians, 32 species of reptiles and more than 101 species of mammals have been reported from the area (Inskipp & Inskipp 2001; KMTNC-ACAP 1997). The area is inhabited by approximately 120 000 people from five major ethnic and other tribal groups (Bajracharya 2002). Traditionally, the people of the region are highly dependent for their livelihoods on natural resources, particularly native forests.

The present research focused on the southern slopes of the Annapurna range (Fig. 1), which is the area most affected by ACA management policies and is relatively homogeneous ecologically with significant forest cover. Care was taken to select study communities that are characteristic of the region. Study sites were selected using a stratified random approach, on the basis of existing information and preliminary field visits. Stratification was performed on the basis of ethnic composition, resource-use patterns, topography, climate, altitude and vegetation type. The study areas lie within the subtropical to temperate climatic zones, with a mean annual temperature of 16.3°C, and a mean annual rainfall of approximately 5000 mm. The study sites were divided between two areas, surrounding the villages of Ghandruk (Kaski district) and Bhujung (Lamjung district) respectively. Within both of these areas, villages inside and outside ACA were selected, with 14 villages selected in total. These were (1) inside ACA: Chhomrong, Dangsing, Ghandruk, Landruk and Sabet in the Kaski district; Baghum and Bhujung in the Lamjung district; and (2) outside ACA: Aantighar, Mauja and Sarangkot in the Kaski district; Bhulbhule, Maling, Ngadi and Taksar in the Lamjung district.

The villages studied lie at 820–2100 m altitude, with most lying at 1600–1800 m, and were 3–8 hours walking distance from the nearest road passable to motorized vehicles. The mean ($\pm$ SE) number of households per village was 92 ± 11.3, with a mean of 6.5 individuals per household. The main ethnic group in all cases was Gurung, but Magar, Brahman and Chhetri groups were also present. In addition, the Damais, Kamis and Sarki caste groups were present in all villages, many providing agricultural labour but typically owning little land themselves. All of these village communities are dependent on wild resources for fuelwood, fodder and timber. Natural forests are a common property resource, accessible to all members of the community. Agricultural land is always privately owned, but may include woodlots of planted trees.

Agriculture is practised on terraced hill slopes. The principal crops grown are maize, millet and rice. Livestock farming (principally buffalo and cattle) is also carried out in all of the villages.

At the lowest altitudes, the vegetation of the area is characteristically subtropical forest dominated by *Schima wallichii* and *Castanopsis indica* (Gurung 2000; Inskipp & Inskipp 2001). Above 1500 m, this is replaced by mixed broadleaved temperate forest dominated by oaks (*Quercus lamellosa* and *Q. semecarpifolia*), with *Rhododendron* species dominating the forest at altitudes above 2200 m.

Forest assessment

To assess the impact of human activity on forest resources, field plots were surveyed along transects from villages located both within and outside ACA. Field surveys were only undertaken in the Ghandruk area because of the security risks caused by an armed Maoist insurgency in the eastern part of the study area. The villages included in the forest survey were therefore limited to (1) Chhomrong, Ghandruk, Landruk, Sabet and Dangsing inside ACA, and (2) Sarangkot, Mauja and Aantighar outside ACA. The forest sites surveyed were identified through participatory resource mapping exercises undertaken with the village communities, as the primary areas from which forest products were harvested. Within ACA, these sites primarily lie within the area in which villagers are allowed to collect wild resources for subsistence purposes as defined in the Operational Plan (Sherpa *et al*. 1986).

Four plots were surveyed along a single transect extended outwards from each village, to test the hypothesis that more accessible forest areas are subjected to a higher intensity of human impact. In each case, linear transects were situated upslope from the villages, orientated along principal harvesting routes. Sample plots were established at different travel times along each transect, rather than distances, as this gives a more precise indication of accessibility, given the highly mountainous terrain. Sample plots were sited at intervals of 45 minutes walking time from the first sample plot, which was established at the edge of the forest area identified in the mapping exercise. Each transect was situated on a mean slope of $30^\circ \pm 2.2^\circ$ and a mean altitude 2200 ± 48 m inside ACA and $25^\circ \pm 3.0^\circ$ of slope and 1550 ± 95 m outside ACA. Slopes were generally north or east facing.

At each sample point, a $10\,m \times 10\,m$ plot was established, within which we measured the diameter at breast height (dbh) of all trees ≥ 10 cm dbh and recorded the number of stems of each species. Stems originating as resprouts from cut stumps were counted as individual stems. Each individual tree was identified to species by reference to standard taxonomic works (Polunin & Stainton 1984; Storrs & Storrs 1984). Within each 10×10 m plot, single random sub-plots of $5\,m \times 5\,m$ and $2\,m \times 2\,m$ were established for assessing tree saplings and seedlings, respectively. Saplings were defined as stems less than 10 cm dbh and $\geq$ than 30 cm in height to the terminal bud. Seedlings were defined as stems <30 cm in height. We determined the number of stems of each species in each sub-plot. An Abney level was used to measure the degree of slope of each plot, and an altimeter was used to measure elevation. A lightweight mirror compass (Suunto, Carlsbad, USA) was used to measure aspect.

Along each transect, we recorded direct (for example actual sightings) and indirect (for example pellets and tracks) evidence of wild animals. Evidence of livestock grazing in each sampled plot was recorded by counting grazing animals and/or dung of the animals. Evidence of human disturbances was provided by cut stumps and logs and these were counted and recorded in each plot. To verify the fuelwood species harvested within ACA, a sample survey of fuelwood species in stacks of wood collected by 41 randomly selected households in four of the villages was also carried out. Species diversity was estimated using the Shannon-Wiener index, given by:

$$H = \sum_{t=1}^{s} (p_i)(\log_2 p_i)$$

where H is the index, s is number of species; p_i is the proportion of individuals found in the ith species n_i/N (Magurran 1988). Species evenness was measured as H/ ln s where s is the total number of species. We also calculated Simpson's index (D), a measure of diversity which takes into account both richness and evenness, following Magurran (1988), where:

$$D = \sum (n/N)^2,$$

n = the total number of organisms of a particular species, and N = the total number of organisms of all species.

A t-test was used to compare more than one set of means. The Anderson-Darling normality test was used to confirm normality (Minitab 2000). If the data were not normal, then the data were log transformed prior to analysis. Data that were not normally distributed even after transformation were analysed using non-parametric tests (Mann-Whitney U-test or Kruskal-Wallis test). The ecological data were analysed in Minitab r. 13.1 (Minitab Inc., State College, PA, USA).

Social survey

The social survey involved a combination of participatory research methods followed by structured interviews and a questionnaire survey in each of the sampled villages. We used a participatory matrix ranking and scoring on a 1–5 point scale to assess community perceptions of different fuel sources and changes in wildlife populations. Matrix ranking and scoring techniques were also used to assess changes in wildlife populations, facilitated by the use of wildlife photographs. Social data rather than biological survey information were collected for these variables because the objective of the research was to assess how wildlife populations interact with human activities. Therefore the survey concentrated on the impact of wildlife as perceived by individuals in each village.

We undertook semi-structured interviews to gather data on conservation awareness, attitudes towards conservation, resource-use patterns and relationships with ACA staff. The interviews were conducted between November 2001 and February 2002 based on a pre-designed structured questionnaire (full details in Bajracharya 2004). Respondents were asked a series of pre-established questions with pre-set response categories. The questions were presented in an informal way to establish greater trust and dialogue, and increase opportunities for other information to emerge. The interview team consisted of three persons experienced in questionnaire surveys, able to develop an appropriate rapport with the respondent. The interviews were conducted in Nepali or in local Gurung dialect.

The questionnaires included both fixed-response and open-ended questions. In some cases, the respondents were invited to score the extent to which they agreed with the statement offered. A five-point Likert scale was used in this context, with 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, and 5 = strongly disagree. The questions were written in Nepali. Stratified sampling was carried out at the household level, based on occupation, gender and role within the community. Households within each stratum were selected randomly such that 15% of the total households from each village were interviewed. In each survey village, interviews purposely included at least two chairpersons from among various functional local institutions such as village development committees (local village government), conservation area management committees, mothers' groups, tourism management groups and youth groups, identified during the participatory rural appraisal (PRA) exercises.

The social data were analysed using SPSS v. 10.0 (SPSS Inc., Chicago, USA). A χ^2 test was used to analyse frequencies. A *t*-test was used to compare means. We used the Anderson-Darling normality test (Minitab 2000) to test the data and, if not normal, then the data were log or arcsinh transformed. If data were not normally distributed after transformation, then the Mann-Whitney U-test was used to compare medians.

Table 1 Density, basal area, species diversity and species evenness of all the trees ≥ 10 cm dbh in the twenty-five plots within ACA and twelve plots outside ACA (mean ± SE).

	Inside ACA	*Outside ACA*	*p*
Density (trees ha^{-1})	1830 ± 256	1561 ± 165	Not significant
Basal area (m^2 ha^{-1})	114.6 ± 15.5	50 ± 16.8	0.001
Shannon-Weiner index	1.28 ± 0.90	0.91 ± 0.11	0.01
Species evenness	0.80 ± 0.04	0.74 ± 0.05	Not significant
Species richness	43	23	
Simpson's index of diversity	0.633 ± 0.20	0.499 ± 0.17	Not significant

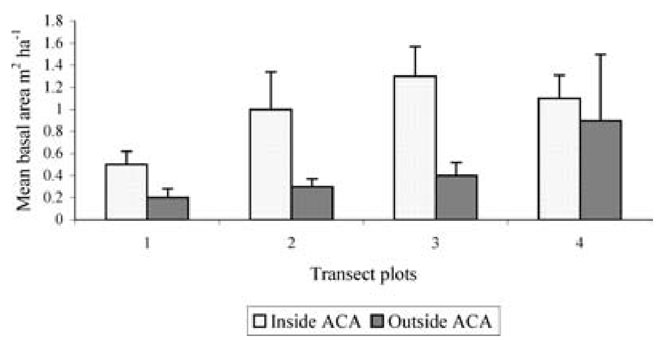

Figure 2 Comparison of mean (+SE) total basal areas of different sample plots along transects both within and outside of ACA (positions 1–4 indicate increased travelling times from nearest village, at intervals of 45 minutes).

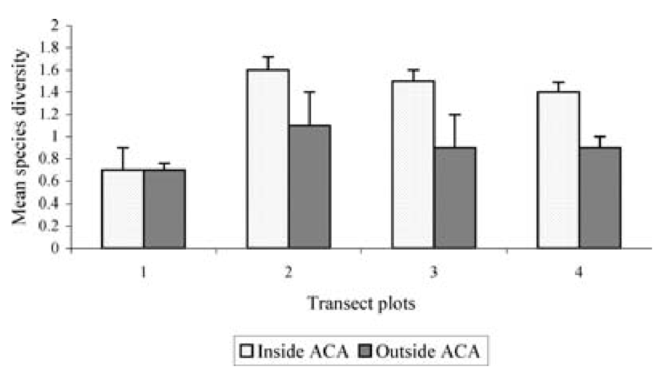

Figure 3 Comparison of mean (+SE) tree species diversity (Shannon index) for different forest plots along transects both within and outside of ACA (positions 1–4 indicate increased travelling times from nearest village, at intervals of 45 minutes).

RESULTS

Forest structure, tree species diversity and resource use

A total of 43 tree species were recorded at the study sites inside ACA and 23 tree species recorded outside ACA (Table 1). There was no significant difference (Mann-Whitney test, $p > 0.87$) in the tree density between plots within and outside ACA. Higher mean total basal area was recorded inside ACA than outside (Mann-Whitney test, $W = 574$, $p = 0.001$), the basal area being lower in plots closer to villages (Fig. 2; Kruskal-Wallis $H = 8.15$, $p = 0.04$).

Tree species diversity was also found to be higher inside ACA than outside. The mean Shannon index of diversity was higher in ACA than outside ACA (Mann-Whitney test, $W = 550$, $p < 0.01$; Table 1). A significant difference in species diversity was also recorded among plots within ACA (Kruskal-Wallis test, $H = 12.8$, $p = 0.005$; Fig. 3), however, the species evenness and Shannon index were similar among the plots (Mann-Whitney test, $p > 0.05$ in each case; Table 1).

Sapling (≥ 30 cm high and < 10 cm dbh) and seedling (< 30 cm) densities estimated from the sub-quadrats sampled in each plot showed no difference between ACA and outside ACA: sapling density (mean $\pm$ SE) inside ACA 5476 ± 1287 ha^{-1}, outside ACA 5984 ± 983 ha^{-1} (*t* test, $p = 0.12$); mean seedling density ($\pm$ SE) inside ACA 19108 ± 3498 ha^{-1}, outside ACA 15548 ± 4419 ha^{-1} (Mann-Whitney test, $W = 484.5$, $p = 0.77$).

The cutting of trees for timber and fuelwood and grazing of domestic animals were the two major disturbances to the forest in the study area. The mean cut-stump density ($\pm$ SE) in ACA was significantly lower (716 ± 170 cut-stumps ha^{-1}) than outside (1785 ± 275 cut-stumps ha^{-1}) (Mann-Whitney test, $W = 376.5$, $p < 0.001$). No difference was recorded in the number of grazing animals or dung pellets inside and outside ACA (35.8 ± 19.3 versus 16.7 ± 16.7 grazing animals ha^{-1}, respectively, and 127.3 ± 44 and 59.3 ± 50 dung pellets ha^{-1}, respectively; Mann-Whitney test, $p = 0.72$ and $p = 0.33$, respectively).

Matrix ranking of fuel sources indicated that electricity and liquid petroleum gas (LPG) were the preferred main fuels, supported by micro-hydro power and by the relative ease of obtaining kerosene and LPG supplies. People perceived that use of wood as the only source of fuel had detrimental effects on their forest resources. PRA exercises indicated that the fuelwood collection from the forest had been reduced by half compared to a decade earlier. Various reasons were given for this, namely increased conservation awareness, efficient use of fuelwood through introduced technologies and behavioural changes, use of fire only when needed, collection of only dry and dead wood, planting of fuelwood species on farms and harvesting of wood from private woodlots. Felling of large trees and stockpiling of wood within the forest has been abolished from ACA villages.

A sample survey of tree species in fuelwood stacks in the selected villages inside ACA found 29 species used in total. Out of 41 households surveyed, the wood from the *uttis* tree (*Alnus nepalensis*) was the most abundant in fuelwood stacks (dominating stacks in 77% of the surveyed households). *Bilaune* (*Maesa chisia*), *chutro* (*Berberis aristata*), *jhyanu* (*Euria acuminata*) and *dab dabe* (*Symplocus ramosissima*) were other minor species in fuelwood stacks. *Falant* (*Quercus lamellosa*), which emerged as a highly preferred fuelwood species in the PRA exercises, was reported from only 7.3% of the 41 surveyed households.

The participants in the PRA exercises also reported a substantial decrease in collection of other products such as fodder and non-timber forest products. Reasons given were an increase in use of farm fodder, a reduction in the number of livestock and increasing conservation awareness. Collection of two major non-timber forest products, particularly *nigalo* (*Arudinaria* spp.) and nettle fibre plants (*Girardinia diversifolia*) has also decreased. *Arudinaria* spp., which were widely used for construction of agricultural implements, have been gradually replaced by plastic items. Similarly, imported clothes have replaced nettle fibre products, which were used for weaving traditional clothing. The residents have shifted towards market-based products because these are easily available, and production of traditional woven clothes and mats was labour intensive.

Table 2 Perceptions of wildlife populations based on the participatory wildlife matrix (scoring 1–5, where 1 is low and 5 is high) (mean $\pm$ SE).

	Mean matrix score			
	1971	*1981*	*1991*	*2001*
Inside ACA	2.00 ± 0.10	2.30 ± 0.20	3.10 ± 0.20	4.26 ± 0.10
Outside ACA	2.25 ± 0.30	2.25 ± 0.30	2.75 ± 0.30	2.80 ± 0.20

Evidence for changes in wild animal populations

The participatory wildlife matrix scoring suggested that wild animal populations inside ACA have increased following conservation intervention. Mean abundance scores for wild animals in 1971 and 2001 inside ACA were 2.0 and 4.24, respectively, whereas the mean scores outside ACA were 2.48 and 2.80, respectively (Table 2). Participants also reported an increase in the population of musk deer, which was once thought to be locally extinct owing to commercial hunting. Semi-structured interviews with the members of local communities showed that a majority of the respondents (80%, $n = 114$) in ACA believed that wild animals have significantly increased, whereas only a quarter of the respondents outside the area expressed the same view.

Track counts, pellets counts and direct observations also suggested significant differences in the wildlife populations between the ACA and outside it. The mean sighting ($\pm$ SE) of mammals such as barking deer (*Muntiacus muntjak*) and Himalayan tahr (*Hemitragus jemlahicus*) during forest surveys in 25 plots within ACA were 0.56 ± 0.26 sightings plot^{-1}. No sightings occurred outside ACA. The mean pellet group count ($\pm$ SE) was significantly higher inside ACA (156 ± 68.3 pellet groups ha^{-1}) than outside (none) (Mann-Whitney test, $p = 0.03$). However, these observations were limited to a small sample size and only one season, and should therefore be viewed with caution.

Perceptions of wildlife population changes and hunting behaviour were different between the two study areas (Table 3). Mean scores for individual perception statements were 4.02–4.70 (five-point scale) inside ACA and 2.03–4.21 outside ACA. Respondents in ACA reported frequent sightings of wildlife inside the forest with a mean score of 4.11 inside ACA and 2.75 outside. ACA residents reported larger changes in wildlife populations and hunting behaviour compared to outside ACA (Mann-Whitney test, $p \leq 0.01$). A majority of respondents both within ACA and outside (83%, $n = 89$ and 66%, $n = 61$, respectively) strongly disagreed with continuing hunting. However, a majority of the residents

Table 3 Perception of respondents towards wildlife conservation as indicated in the questionnaire survey with community members (SA = strongly agree; A = agree; N = neutral; D = disagree and SD = strongly disagree. Respondents assigned a score of 5 for SA, 4 for A, 3 for N, 2 for D and 1 for SD).

Perception statements	*Responses (%)*					*Mean*	*± SD*
	SA	*A*	*N*	*D*	*SD*		
Inside ACA (n = 89)							
Protection of forest increased wildlife	80	15	3	2	0	4.7	0.6
Wildlife is frequently encountered in the forest	53	29	8	2	8	4.2	1.1
Villagers still hunt	2	7	3	5	83	1.4	0.9
Pest wildlife should be killed	61	12	10	7	10	4.0	1.3
Outside ACA (n = 61)							
Protection of forest increased wildlife	49	30	18	2	1	4.2	1.5
Wildlife is frequently encountered in the forest	15	21	23	10	31	2.8	0.9
Villagers still hunt	15	10	2	8	65	2.0	1.6
Pest wildlife should be killed	33	24	10	3	30	3.3	1.6

inside ACA (73%, $n = 89$) compared to about half outside the area (57%, $n = 61$) identified the need to control pest wildlife species.

Conservation awareness and attitudes among local communities

A majority of respondents inside (98.2%, $n = 114$) and outside ACA (77.6%, $n = 85$) believed that they were involved in conservation activities. Within ACA, activities included tree planting on community and private farmland (68.4%, $n = 114$), active involvement in conservation decisions through various local institutions (70.2%), initiatives to control illegal poaching activities (34.2%) and other conservation activities such as regular village clean-ups (53.5%). Involvement of the residents outside ACA in these conservation activities was relatively low (< 30% in each case). All the respondents in ACA (100%) and most outside ACA (94.1%) reported positive changes in their village over the past decade (Table 4). Increases in greenery and wildlife, and improvements in village sanitation and infrastructure development were the major perceived changes.

Table 4 Perceived changes in the village within and outside ACA over a decade (based on results from semi-structured interviews).

Perceived changes	*Inside ACA (%) (n = 114)*	*Outside ACA (%) (n = 85)*
Positive changes noted	100	94.1
Greenery in the village increased	92.1	51.8
Wildlife population increased	79.8	24.7
Village sanitation improved	77.2	70.6
Village infrastructure developed	89.5	58.8

DISCUSSION

The creation of ACA appears to have had an effect on forest structure and diversity, supporting other recent research indicating that, in general, PAs tend to conserve biodiversity (Bruner *et al.* 2001) and support higher forest basal area (Vermeulen 1996). The effect can be attributed to the influence of ACA on patterns of forest use by local people. Communities within ACA now harvest less wood than outside the PA, indicated by the significantly lower number of cut stumps in ACA compared to outside. Measures such as the introduction of alternative forms of energy, conservation education and the availability of fuelwood on private woodlots appear to have been successful in reducing pressure on native forests.

KMTNC-ACAP (1987) reported the use of 25 kg day^{-1} fuelwood by a household, 250 kg day^{-1} by a tourist lodge and 100 kg day^{-1} by an organized trekking group. Household fuelwood use in the 1990s was 10–15 kg day^{-1} while a tourist lodge used 100 kg day^{-1} (Saito 1990). More recent studies suggest that use has continued to decline, with values of 9–11 kg being used daily per tourist lodge and 8 kg per household (Banskota & Sharma 1996; KMTNC-ACAP 2000). Saito (1990) reported use of more than 90 tree species for fuelwood, whereas this study found that only 29 species of fuelwood were used in total, indicating that the variety of fuelwood species used has been reduced significantly. This decline in fuelwood use has been complemented by increased tree planting efforts. More than 1 666 000 tree seedlings were planted on communal lands and private farmlands in ACA by the local communities during 1986–2000 (KMTNC-ACAP 1997, 1999, 2001). Successful tree planting was not observed outside ACA. As noted by Khatry Chhetri (1999), the rate of biomass production by temperate forests in the Himalayas is relatively high but, without some form of protection, human activities can have a substantial negative impact on forest biomass.

A majority of the residents in ACA reported a trend of increasing abundance of selected wild animal species. This can largely be attributed to effective implementation of policies aimed at controlling wildlife hunting by the local communities through local committees. The majority of local communities in ACA have abandoned hunting of animals such as barking deer (*Muntiacus muntjak*), common goral (*Naemorhedus goral*), Himalayan thar (*Hemitragus jemlahicus*) and kalij pheasant (*Lophura leucomelana*), which were previously game animals sought after by the local communities. Generally, such hunting was not for subsistence purposes (Sherpa *et al.* 1986). The local communities are now also able to control recreational hunters from urban centres and peripheral villages. This result contrasts with experience in other areas; for example it was reported that hunting pressure is high in almost all forest PAs in West Africa (Oates 2002). However, as reported elsewhere (Infield & Namara 2001), in the present study some people reported occasional killing of animal species such as rhesus macaque (*Macaca mulatta*), Indian porcupine (*Hystrix indica*) and barking deer, which were considered a threat to livelihoods as they cause damage to crops.

Control of the hunting of wild animal species with high commercial value (such as Himalayan musk deer, *Moschus chrysogaster*) has not been so effective. Evidence of hunting records in ACA and discussions with the Conservation Area Management Committee (CAMC) members indicated that people from other districts carried out most of these hunting activities and they were often linked to a commercial hunting network. This occasional hunting occurs primarily because of external demand for wildlife products such as musk. Records indicate that there were only seven illegal hunting cases filed from 1998 to 2002 (KMTNC-ACAP 2002), a relatively low value compared to other national parks and wildlife reserves in Nepal (DNPWC [Department of National Parks and Wildlife Conservation] 1993, 1995; Anon. 2001; Phuyal 2003). However, the Maoist insurgency that has been affecting many rural areas of Nepal in recent years has fostered lawlessness and is thought to have increased the level of poaching in ACA.

Compared to villages outside ACA, a relatively high proportion of people reported encounters with wild animals in ACA. Together with the direct sighting and pellet count data, this supports suggestions that populations of wild animals in the PA are stable or increasing. A study of Himalayan tahr populations in ACA indicated that there is a sizeable population of the species in the area (Gurung 1995), which increased by an estimated 20% over a five-year period (Shrestha & Ale 2001). The koklass pheasant (*Pucrasia macrolopha*) and satyr tragopan (*Tragopan satyra*) populations have been stable in ACA for 20 years, whereas most Himalayan pheasant species are thought to be declining elsewhere (Kaul & Shakya 1998). It is important to note that conservation of freshwater fish, however, has not been effective in ACA; focus group discussions between ACA staff and CAMC reported uncontrolled use of electric rod fishing and poisoning in major rivers.

The community-based PA management approach attempts to influence thinking and attitudes in the belief that this will lead to changes in behaviour, although such changes do not always occur (Infield & Namara 2001). The present study suggests that the conservation intervention in ACA has significantly influenced both attitudes and behaviour of the local communities. A strong traditional system of resource management, either through the *Ban Samiti* (Forest Management Committee) or other traditional local management committees, and a culture of working together and good leadership within the ACA villages have catalysed these changes. ACA appears to have been successful in involving a majority of residents in the area. In addition to planting tree seedlings and regular village clean-ups, the majority of respondents in ACA indicated that they were involved in making conservation decisions through various local institutions. This suggests that local communities in ACA have been empowered by being given legal responsibility and authority over the management of resources that were previously government-controlled. The Conservation Area Management Regulation (CAMR) introduced in 1996, under the 1993 amendment of National Parks and Wildlife Conservation Act, provided a legal basis to involve the local communities in conservation, and has been of particular importance in providing power to local communities to control and manage local resources.

The success of community-based PAs often depends on the empowerment of local resource users and on the attention given to the development and strengthening of local institutions, which can represent local communities' interests and concerns (Martin 1997). Local institutions provide leaders, stewards and rules for social regulation (Berkes *et al.* 2000), which are required to make community-based PA management effective and sustainable. They also help to maintain community solidarity and negotiating power in relation to threats (Chambers 1997). There is evidence of the development of such local institutions within ACA. The CAMC has been established as a main local institution for planning, designing, implementing conservation and development plans and programmes in ACA villages. A large majority of the interviewees considered that the CAMC has an important role in conservation planning, policy formulation and ownership of the forest resources. During the initial stages of conservation intervention, the legitimacy of CAMCs was based on a shared value system and collective cohesiveness as in a traditional authority structure (also see Murphree 1994). The conservation area regulation endorsed by the government in 1996 gave a legal designation and role to CAMCs. As foreseen in the ACA Operational Plan (Sherpa *et al.* 1986), income from fines and issue of permits for resource harvesting (for example timber) is deposited into a CAMC account and used for incentives and local development.

As in other countries, where insurgency and lawlessness has led to dysfunction of protected area management, the conservation successes of ACA are imperilled by the current political instability. Over the past few years, all of the ACA field stations in the southern slopes of Annapurna have either been burnt down or damaged and have been forced to close down. About 101 staff based in these four field stations have been shifted to the ACA headquarters in Pokhara or the nearest urban centre. This situation has caused disruption to the linkages between ACA and the local communities. Latterly, most CAMCs on the southern slopes of the Annapurna region have not been functioning effectively owing to the insurgency, which has forced local community leaders to abandon their villages. A prolonged state of insecurity and lawlessness is likely to discourage unified and committed actions of local communities to conserve resources. Furthermore, the Maoist insurgency and the threat of political instability have severely damaged tourism businesses in ACA, resulting in a decline in numbers of visiting tourists, and a reduction in financial resources available for conservation and development interventions. This suggests that the successes of ACA management may be at risk in future, if the insurgency continues.

CONCLUSIONS

The community-based approach to management of ACA has been successful in delivering conservation benefits, substantiated by the higher basal area and tree species diversity in ACA forests than those outside. Poaching of wildlife has decreased and populations of selected wild species are stable if not increasing within ACA. The integration of activities designed to increase conservation awareness, planting of fuelwood species and the provision of alternative energy sources has contributed to reductions in fuelwood collection from natural forests.

There are distinct features of the ACA 'model' that may be unique to the Annapurna area, including the traditional strong communities and way of life, the spectacular scenery stimulating tourism and the dispensation afforded to ACA to retain tourist income. These positive attributes have been augmented by the provision of the ACA infrastructure and expertise. It is debateable, therefore, whether the example of ACA could be extended without modification throughout Nepal or to a wider Himalayan region; however, the wider applicability of the ACA model should not be ruled out.

The success of ACA in delivering conservation benefits can also be attributed to the development and strengthening of local institutions, which represent local communities' interests and concerns. In particular, the role of the CAMC in conservation planning, policy and management of forest resources has been of critical importance. The development of such institutions has strengthened the ability of local communities to control and regulate use of their resources, supporting traditional approaches to community endeavour. However, these achievements are fragile, and appear to be threatened by the current armed insurgency in the area.

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