Assessing community forests' condition using variables recommended by local people: a case of Kaski district, Nepal

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This paper examines the community forests' condition using regeneration, crown cover and tree shape as variables recommended by local people. The total of three survey plots were established in each forest to measure the variables. Community type, vegetation type, number of user households, and income from community forests were identified as community forests' characteristics. Regeneration, crown cover, and tree shape were found to be adequate measuring variables for the community forests condition. Findings showed that the overall community forests of Kaski district are improving. There is a lacking in silvicultural operations in the community forests. The lack of silvicultural operations in the forest would produce inferior quality of trees. The fund size of the forest user group found to be associated with crown cover.

Key words: community forests, Forest User Group, crown cover, regeneration, tree shape, forest stocking, Nepal

Forest improvement is an indicator to measure the success of Nepal's community forestry program (Pokharel, 2003). In the past, various methods have been used to measure the forest condition depending upon objectives of the study and researcher's individual preferences. Becker and Leon (2002) used diameter at breast height (DBH), basal area and diversity of trees to represent the condition of a forest in Balivian Amazen. Gibson (2001) used structural variables including DBH, basal area, and density of trees and saplings to represent forest condition. Tachibana *et al.* (2001) used aerial photo to analyze the condition of forest in the mid-hills of Nepal.

Crown density is commonly used to assess the forest condition (Solberg and Moshaug, 1999; USDA, 2003). It indicates the amount of plant materials, such as leaves and branches that block sunlight from reaching the ground. It is measured by indicating the percentage of total light that is blocked by the tree canopy. Crown density differs among the tree species and is affected by tree shape and growing conditions.

Natural regeneration, crown cover, and tree shape are the variables used for measuring the community forests condition (Pokharel, 2003). Regeneration indicates the species composition and stability of future (Piussi and Farrell, 2000). Natural regeneration is high for species such as sal (Shoria robusta) in many areas where forests are protected from grazing livestock (Pardo, 1995). Occurrence of natural regeneration in the forest is an indication of effective user group management (Tachibana et al., 2001).

Tree shape is very important in the quality of wood products. A good tree shape can provide high timber value in terms of quantity and quality as well as fuel wood and fodder, which provide additional benefits to forest users. For these reasons the local people perceive tree shape as an indicator to assess the improvement of community forests. A study conducted by Hull et al. (2001) observed tree shape as an indicator of forest health as perceived by the public.

This paper describes the techniques used to assess the current status of community forests. The purpose of this paper is to explain the community forests' condition in the Kaski district using the variables recommended by local people. The paper also attempts to address the additional question of what the relationship between community forests' characteristics and regeneration class, crown cover, and tree shape are.

Location of the Kaski district

Kaski, one of the hill districts is situated in the mid-hills of Nepal. The district lies in the Gandaki zone

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of the western development region (Figure 1). It is located in the center of the country between 28° 06' –28° 36' north latitude and 83° 40' - 84° 12' east longitude.

The total population of the district is 380,527 consisting of 195,532 females and 184,995 males (CBS, 2002). There are 85,075 households with an average family size of 4.47. The literacy rate of the district is 71 percent, higher than the national literacy rate (54%).

The district experiences a sub-tropical, temperate, tundra, and alpine type of climate as its altitude varies from 450 meters to 7,939 meters. The absolute maximum temperature in Pokhara is 37.4 degree Celsius and the minimum is 2.4 degree Celsius with mean annual precipitation of 3,710 mm (Jackson, 1994). The district has a total area of 2,017 square kilometers of which 42 percent is covered by forests.

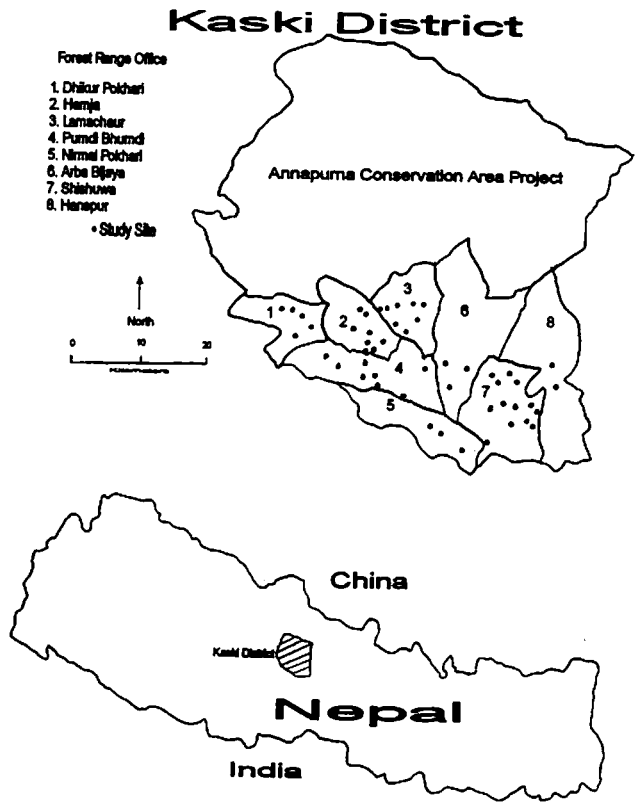

Figure 1. Location of study areas

Study procedure

This study was designed as a descriptive research survey and used both qualitative and quantitative data collection approaches. The main purpose of the study was to pilot test the variables as perceived by local people to assess the community forests condition and measure them accordingly.

Workshop for FUG representatives and forestry technicians

A one-day workshop was organized in September 2002, at the Institute of Forestry, Pokhara, Nepal for Forest User Group (FUG) representatives and local forestry technicians of the Kaski district. Altogether 13 representatives (four females and nine males) of the FUG and three local forestry professionals participated in the workshop. The workshop recommended forest improvement as one of the indicators to measure the success of the community forestry program. The workshop further suggested crown cover, natural regeneration, and tree shape as physical and biological variables for measuring the condition of community forests. A checklist was developed during the workshop to gather basic information about the community forests.

Population and sample

Forest assessment was conducted in places as shown in Fig. 1. The target population for this study was forest patches of the Kaski district that were managed as community forests. As of September 13, 2002, 384 forest patches were managed as community forests in the Kaski district and were considered as the population for this study.

A purposive sample was used to select the district, as it is one of the hill districts where the community forestry program is being implemented. This study utilized a stratified random sampling to understand the community forests' condition. The forests were stratified into two categories (large and small) based on the forest area. Forests with more than five hectares were considered large and those with five hectares or less were considered small. A total of 50 forests (24 small and 26 large) were randomly selected for this study.

Data collection

A team composed of one of the authors and three undergraduate forestry students was formed to conduct the field survey. The author trained the students for three days in measuring crown cover, regeneration, and tree shape.

The team first approached the chairman/secretary of the Forest User Group Committee (FUGC) to collect basic forest information such as forest area, and number of households. The team then visited the respective forests to assess (a) natural regeneration, (b) crown cover, and (c) tree shape.

Establishment of study plots

A total of three survey plots were laid out on each forest. The survey plots were selected randomly by walking on a trail in the forest as a transect line. The plots were established along the transect line at the distance of five meters inside either left or right, depending on the accessibility. Each plot was established at 50 meters intervals. The transect line with a random start was placed a distance of ten meters from the forest's entrance to avoid any settlement effect, as suggested by Rayamajhi and Pokharel (1998). The vegetation on each plot was stratified by size, as suggested by Henning and Dickmann (1996): ground vegetation (tree species < 1.4 m tall), under-story (tree species > 1.4 m tall and < 10 cm in diameter at breast height), and over-story (tree species with e ≥ 10 cm diameter at breast height).

Plot size

Plot sizes of two types were laid down separately for ground vegetation (1 m^2) and under-story/over-story vegetation (100 m^2). A square plot of a hundred square meters, 10 m X 10 m was established for each plot to measure tree shape, tree diameter, and tree height. In the survey plot, the diameter and height of woody over-story (e ≥ 10 cm diameter) and diameter of under-story (< 10 cm diameter) was measured. The tree diameter at breast height and tree height of tally trees were measured using a diameter tape and sunto clinometer, respectively. At least two to three different variable-sized trees were measured on each plot for their accurate height and the remainders were estimated based on the difference in height of the measured trees.

Natural regeneration

Regeneration was measured following a nested plot of one square meter as described by Metz (1991) and Henning and Dickmann (1996). A nested plot of one square meter was laid out on the left lower corner of the larger plots (100 m^2). The nested plot was established in each larger plot where natural regeneration of tree species was counted.

The average available plants in one square meter was converted into plants available per hectare and ranked the regeneration class as described by Jackson and Ingles (1995): very sparse meaning < 500 plants per hectare, sparse meaning 500 – 1,499 per hectare, moderate 1,500 – 5,000 per hectare, and high meaning > 5,000 per hectare. Natural regeneration was measured on a scale of 1 to 4 with 1 meaning very sparse, 2 meaning sparse, 3 meaning moderate, and 4 meaning high.

Crown cover (Tree canopy)

Tree canopy was measured using the crown separation ratio method as described by Metz (1991). Crown separation ratio was converted into crown cover percentage. Crown cover percentage helps to determine forest stocking where stocking describes the density of the forest. Crown density also gives an indication of the forest's stock.

Crown width and gap width of 12 trees in each survey plot was carried out. On each designated plot, a reference tree was randomly selected and the crown width and gap width of the 12 nearest trees were measured systematically (Metz, 1991).

Average crown separation ratios were converted into percentages and categorized the forest as described by Jackson and Ingles (1995): very sparse meaning less than 20% of the ground is covered by crown, sparse meaning 20 – 39% of the ground is covered by crown, moderate meaning 40 – 70% of the ground is covered by crown, and high meaning greater than 70% of the ground is covered by crown. The tree canopy was measured on a scale of 1 to 4 with 1 meaning very sparse, 2 meaning sparse, 3 meaning moderate, and 4 meaning high.

Tree shape

Local people refer to tree shape to indicate tree quality. Tree quality is based on the present or prospective form, roughness, and soundness of a tree regardless of species (HMG/N, 1993). The tree quality is a subjective judgment based on the tree's present condition. The research team made the judgment on tree quality based on the present or perspective form, roughness and soundness of a tree regardless of tree species and measured accordingly.

Tree shape was measured on a scale of 1 to 3 with 1 meaning poor (about 80% of the trees are crooked or diseased and dying state), 2 meaning moderate

(partly twisted tree and about 60% of its parts are usable for timber), and 3 meaning good (about 80% or more is straight in shape and good for timber). The study measured tree quality only for woody over-story vegetation. Tree quality of each plot was calculated by averaging the tree shape score. The average tree quality of the forest was obtained by averaging the mean score of each plot.

Data Analysis

The collected data of regeneration, crown cover, and tree shape were entered into a Microsoft Excel Spreadsheet. The average number of seedlings in a plot was converted into plants per hectare and rated the regeneration class of the forest accordingly. Similarly, the average crown separation ratio of a plot was calculated and converted into crown percentage and then crown percentage of the forest was measured accordingly. The average tree shape score of a plot was calculated and the mean score of 1 to 1.49 was classified as poor tree shape, 1.5 to 2.49 as moderate, and 2.5 and higher as good for the forest.

The data of forests' regeneration, crown cover, and tree shape were transferred to a Statistical Package for the Social Science (SPSS) datasheet. The data from the checklist were coded and analyzed using the SPSS version 11.0. Frequencies, and percentages were generated to report the status of the forests. Chi-square and analysis of variance (ANOVA) tests were performed to determine the relationship between community forests' characteristics and community forests condition (natural regeneration, crown cover, and tree shape).

Findings

Characteristics of the community forests

Some characteristics such as vegetation type, community type, income generation, forest area, and number of households were identified as characteristics of the community forests. Table 1 shows that 80 percent of the sample community forests contain broadleaves species and 20 percent having mixed species of broadleaf and conifer species. Broadleaves species are trees with broadleaf, not needles. Many forest users in the study area preferred broadleaf species as they use them for fodder, and leaf litter (broadleaf is good for compost as compared to conifer species). Over 60 percent of the community forests were managed by a homogenous community (more than two-thirds of the users either the same caste or ethnic groups). More than two-thirds of the community forests were generating income from the forest via various sources such as sales of forest products, especially timber, penalty, and membership fees. Fires did not damage the overwhelmingly majority of the forest in the last five years, which indicates that the users are effective in controlling the forest fires. Almost three-quarters (72%) of the community forests do not allow grazing in the forest (Table 1).

The forest area ranged from 1.02 ha to 134 ha; the average area was 17.7 hectares. The number of households ranged from 14 to 315 households; the average number of households in each community forest was 82.9. Similarly, the annual income from the community forest ranged from Nepalese Rupees (NRs.) 450 to 30,000; the average income was NRs 4,139. For analysis purpose, the data on variables such as number of households, forest area, forest area per household, and annual income were divided into 5, 4, 3, and 3 categories, respectively (Table 2).

As shown in Table 2, the largest portion (42%) of the forests was more than 10 hectares in size whereas 16 percent was less than 2.5 hectares. The number of households with 31 to 60 and more than 120 each, composed almost one-quarter (24%) of the sample

Table 1. Characteristics of sample community forests (N = 50)

Characteristics of community forests		Number of community forests	Percentage
Vegetation type	Broad leaf	40	80
	Broad leaf and conifer species	10	20
Community type	Homogeneous	31	62
	Heterogeneous	19	38
Generating income from the forest	No	16	32
	Yes	34	68
Was community forest damaged by fire	No	45	90
in the last five years?	Yes	5	10
Is grazing allowed in the forest?	No	36	72
	Yes	14	28

Table 2. Basic characteristics of sample community forests (N = 50)

Basic characteristics of community forest		Number of community forests	Percentage
Forest area in hectare	< 2.5	8	16
	2.5 – 5.0	16	32
	5.1 – 10.0	5	10
	10.1 and above	21	42
Number of user households	≤ 30 households	11	22
	31 – 60 households	12	24
	61 – 90 households	8	16
	91 – 120 households	7	14
	121 households and above	12	24
Forest area per household (ha)	<0.5	43	86
	0.51 – 1.0	5	10
	1.1 and above	2	4
Annual income from the forest in NRs	< 2,000	16	47.1
	2,100 – 4,000	12	35.3
	4,100 and above	6	17.6

Note: Average annual income and standard deviation is NRs. 4,139 and 6,189 respectively.

forest. Almost one-half (47%) of the FUGs were earning less than NRs. 2,000 annually whereas over one-half (53%) earning in between Rs.2,100 to 4,000 and over.

It was observed that the FUG members were not fully depending on the community forests to meet their forage and fodder needs. They relied on alternative sources such as private forest and national forest. The users in the study area used more than one community forest as one household could become a FUG member in any number of community forests in the village provided they complied with their rules.

Table 3 shows the forest products collection policy for the sample community forests. An overwhelming majority of the community forests allow grass/fodder (92%) and fuel wood (80%) collection. One-half (50%) and almost one quarter (22.4%) of the sample community forests allow timber and pole collection, respectively. In many cases, the FUG had not developed a policy for collecting non-timber forest products from the forest. They thought there was no need to develop the collection policy for non-timber forest products (NTFP) as NTFP are rarely found in their forests.

Community forests conditions

Regeneration, crown cover, and tree shape was measured to understand the community forests condition. The status of natural regeneration, crown cover, and tree shape of sample community forests is presented in Appendix A.

Table 4 shows the status of tree shape, crown cover, and regeneration of the sample community forests. Over one-half (54%) of the forests studied had medium shape of trees, followed by good shape of trees (38%), and poor shape of trees (8%). The forests' crown cover ranged from 26 percent to 95 percent; the average crown cover was 76 percent. The number of seedlings in the sample plots ranged from 0 to 8; the average number of plants was 2.69.

Table 3. Forest user groups' current policy on forest products use (N = 50)

Forest products collection from community forest			Number of community forests	Percentage
Grass/fodder	(n = 50)	No	4	8
		Yes	46	92
Leaf litter	(n = 50)	No	18	36
		Yes	32	64
Fuel wood	(n = 50)	No	10	20
		Yes	40	80
Timber	(n = 50)	No	25	50
		Yes	25	50
Pole	(n = 49)	No	38	77.6
		Yes	11	22.4
Non-timber forest products	(n = 18)	No	10	55.6
		Yes	8	44.4

For analysis purposes, crown cover and natural regeneration were divided into three categories (Table 4). Almost three-quarters (74%) of the forests had high crown cover whereas only 2 percent had very sparse/sparse crown cover. Almost one-quarter (24%) of the forest had moderate crown cover. The overwhelming majority (82%) of the forest had high natural regeneration, followed by very sparse/sparse (12%), and moderate (6%).

The majority of the forests contain high crown cover, high regeneration class, and moderate/good tree shape. In Nepal, there is an informal practice in the Forest Department to transfer degraded forest to community for management and utilization purposes. The presence of high regeneration, high crown cover, and good/moderate shape of trees in the forests indicates that the status of community forests is improving. A number of studies support this finding (Bird, 2001; Grosen, 2001; Shrestha, 2001; Springate-Baginski et al., 1999; Varughese, 2000).

Community forest structure

Tree diameter, tree height, and trees/saplings density are the most common variables used to measure forest structure (Gautam, 2002). A common way to measure trees is to record "diameter at breast height" or "DBH" (Brokaw and Thompson, 2000). The DBH of trees with 10 cm or above was measured to understand the size of trees in community forests. Saplings (> 1.4 m tall and < 10 cm in diameter at breast height) were also recorded to understand forest structure. The stand structure of community forests is shown in Appendix B.

The tree diameter and tree height for the sample community forests ranged from 10.00 to 34.81 centimeters and 5.00 to 16.38 meters, respectively. The number of trees per hectare in the study area ranged from 33 to 1,166. Similarly, the number of saplings per hectare ranged from 66 to 4,966. For the analysis purposes, DBH, tree height, and trees/saplings per hectare were calculated (Table 5).

As shown in Table 5, the mean tree diameter and tree height of the community forest is 17.15 centimeters and 9.60 meters, respectively. The average diameter indicates younger trees are more available in the forest rather than mature trees. The average number of trees per hectare in the study area was 511, which is slightly higher than the average number of trees per hectare (449 trees per ha) in the hilly area (HMG/FRISP, 1999). Similarly, the average number of saplings per hectare in the study area was found to be 4,966, which is higher than the average number of saplings recorded in the hilly area. The average number of saplings (stems with the height of more than 1.3 and less than 10 cm DBH) in the hilly area was 1,690 saplings per hectare (HMG/FRISP, 1999).

Table 5. Status of the community forest structures (N = 50)

	Mean	Standard deviation
Diameter at breast height (cm)	17.15	5.19
Height (meter)	9.60	2.54
Number of trees per hectare	511	264
Number of saplings per hectare	4,966	1,731

Association between the community forests characteristics and the community forests condition (regeneration, crown cover class, and tree shape)

The chi-square test was performed to determine the association between forest condition such as regeneration and community forests' characteristics such as community type. The chi-square test was run separately for crown cover, regeneration, and tree shape with community forests' characteristics. The chi-square test showed no association between the community forests conditions (regeneration class,

Table 4. Status of community forest (N = 50)

Elements of community forest		Number of community forests	Percentage
Tree shape	Poor	4	8
	Medium	27	54
	Good	19	38
Crown cover	Very sparse/sparse	1	2
	Moderate	12	24
	High	37	74
Regeneration	Very sparse/sparse	6	12
	Moderate	3	6
	High	41	82

crown cover, and tree shape) and community type, vegetation type, forest products collection policy, occurrence of forest fires, and income generation.

The one-way analysis of variance (ANOVA) was performed to determine the significant difference of mean value of forest condition and community forests' characteristics: forest area, number of user households, and annual income from the forest. The ANOVA results showed no significant difference. However, the results showed significant difference in crown cover and annual income ($F = 7.936$ at $P = .002$). Sparse crown cover shows greater income and high crown cover shows lower income. One can argue that more income in the FUG means poor forest stock. Poor forest stock means fewer number of trees are available at present. It indicates that trees are being harvested to generate income.

Discussions

Improvement in forests condition requires quantifying the changes of conditions using prior data of the forest. Unfortunately, prior data of the forest condition was not available in the area where the study was conducted. The FUG database developed by Ministry of Forest and Soil Conservation/Natural Resource Management Sector Assistance Program (MSFC/NARMSAP) indicates the condition of some community forests in the area but it does not specify time and the measuring variables. So, the data were not used for comparing findings. The descriptions of the community forests are based on a one-time measurement of the forest resources.

Natural regeneration, crown cover, and tree shape are adequate variables to provide a good picture of the forests in terms of species composition, stability of future forest, growing stock, and extent of tree quality. Such information would help to facilitate developing a management strategy of the forest. Over all, the condition of community forests in the Kaski district of Nepal is improving as an overwhelming majority of the community forests contain high crown cover (good forest stocking), high natural regeneration, and moderate/good tree shape. Forest stocking provides information about the availability of block of woods. Similarly, natural regeneration provides information about species composition and stability of the future forest. Tree shape tells us about the extent of tree quality in the forest.

Overgrazing and cutting of saplings for thakra (to support climber plants) and building animal sheds are common problems in the hill forests. In such context presence of regeneration, and good tree shape in the community forests indicate the forest is improving. Saplings have the capacity to grow into trees in future. As future trees, we could consider the density of saplings as an indicator for the future forest condition. The average trees/saplings is higher in the study area than the average number of tree/saplings per hectare in the hilly area. Generally, the Forest Department transfers degraded forests to local communities. The higher number of trees and saplings per hectare in such forests indicate the forest condition is improving. These findings are consistent with those of Varughese (2000) and Springate-Baginski et al., (1999). Varughese (2000) conducted forest stock assessment in various mid hills districts and observed average and above average forest stock for 14 out of 18 community forests. Similarly, he observed the forest condition improving and stable for 6 and 5 community forests, respectively. Springate-Baginski et al. (1999) also observed a significant improvement in community forest condition. They observed the improvement in community forest condition for 10 out of 11 community forests.

Springate-Baginski *et al.* (1999) also observed an increase in natural regeneration in the community forests. A study conducted by Tachibana et al. (2001) in the mid-hills of Nepal indicated that natural regeneration performed well in the forests that were formally managed by communities compared to informal management. These studies support the findings of the occurrence of natural regeneration in community forests.

During the field visits it was observed (the average DBH and saplings per hectare also verify) that many community forests contain young trees with high density. It was noticed that the average number of trees per hectare in the study area was higher which indicates that the FUGs are not performing management practices in terms of silvicultural operations. The silvicultural operation is an essential activity in forest management, which is lacking in the community forests. The people in the area are aware that their forests are dense and require the silvicultural operations. However, they want to continue with their protection–oriented management practices rather than to perform the silvicultural operations. Under protection-oriented management

practices, the cutting of green trees is prohibited and extraction of dead trees alone is allowed in order to meet subsistence needs. The reason for choosing such management practices is the result of past experiences of the consequences of deforestation. They fear that if they allow silvicultural operations that may lead the forest into deforestation.

Such views need to be changed by making people aware of the importance of the silvicultural operations and also to provide related trainings for managing the forests in a better way. It is also important to make the people aware about the negative effects of the protection-oriented management practices. For example, protection-oriented management results in growth and productivity below their potential. Similarly, local people have to walk farther in order to reach government managed forests to collect basic forestry needs.

Many forest user groups have initiated development of community funds through community forests, which is a good start for managing the institution and also maintaining its sustainability. The fund size of forest user groups varies depending on forest stocking because the income size is found to be associated with crown cover. The FUG removed more trees in order to generate more income. Therefore, there is a need to assess the forest stocking before allowing harvesting in the forest.

Conclusions

Crown cover, natural regeneration, and tree shape are adequate variables to assess the forest status as these variables provide a broad picture of forests in terms of natural regeneration, growing stock and extent of tree quality. Local people perceive the improvement in forest condition if they see the occurrence of regeneration, thick tree cover, and good tree shape in the forest. There appears to be a congruency in the measuring variables recommended by local people as rapid vegetation assessment includes the variables such as regeneration and crown cover to measure the forest condition.

Overall, the community forests' condition in the Kaski district is improving as the forests contain good forest stocking, high natural regeneration, and moderate/good shape of trees. The presence of natural regeneration, thick tree cover, and good tree shape in the degraded forests indicate that the forest condition has improved. At the same time the high density of the saplings in the forests implies that the silvicultural operations in the forest is lacking. The lacking of such practice would results inferior quality of trees due to crowding effects. Therefore, there is a need to promote silvicultural practices in the community forests.

Illegal felling, grazing and forest fire in many community forests are under control once the management responsibility shifted from the District Forest Office to the local community. Generating income from the community forest is a good start to run the institution independently. However, the tendency of generating more income can lead to forest destruction.

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