REPORT

The “How” and “Why” of Including Gender and Age in Ethnobotanical Research and Community-Based Resource Management

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Abstract This paper examines the process and outcome of participatory methods for stakeholder identification. We used focus group style participatory methodology to engage local residents in identifying key sub-groups relevant to conservation in Boumba, Niger. We then conducted a quantitative pictorial recognition study to measure the diversity of local useful plant knowledge across groups. The community identified six gender and age-class groupings relevant to the study. The effect of a participant's gender, socially-defined age class or the interaction of the two factors on the number of plants recognized varied by plant use. Medicinal plant knowledge was highest among elders. Food plant knowledge of food plants increased with age for women only. Where as the interaction of age and gender was strongest on fodder plant knowledge, where mid-aged men scored highest. We reflect on the impact that heterogeneity of local botanical knowledge has on our understanding of local natural resource use and the strengths of using a participatory approach to identifying the stakeholder groups which underlie this heterogeneity.

Keywords Participatory research methods · Stakeholder participation · Local ethnobotanical knowledge · West Africa · Niger

INTRODUCTION

Social scientists, development institutions, and now conservationists have been promoting the incorporation of local environmental knowledge to the success of policy and action (Warren et al. 1995; Ticktin and Johns 2002; Krog et al. 2005; Oba and Kaitira 2006). However, despite the increase in rhetoric (Cheveau et al. 2008), many managers and researchers still struggle to engage local knowledge

holders fully in conservation research and action (Stringer and Reed 2007). Researchers cite procedural, financial, political, and methodological barriers to achieving goals of stakeholder or local ecological knowledge integration (Stringer and Reed 2007; Reed et al. 2008). One such barrier to success is the challenge of community or stakeholder representation (Reed et al. 2008). In a literature review, Reed (2008) finds researchers often struggle with the systematic identification and representation of relevant stakeholder groups. This paper seeks to address this challenge of stakeholder analysis, by examining participatory methods of stakeholder group identification and characterization as a part of a larger community-based natural resource conservation research program.

We focus on a subset of local knowledge, ethnobotanical knowledge, which includes the ways people understand and directly interact with plants and their habitats. Ethnobotanical knowledge also encompasses moral, spiritual, and practical institutions that can influence the management and sustainability of natural resources, habitats, and the local capacity to respond to environmental change (Batterbury and Forsyth 1999; Berkes et al. 2000; Salick et al. 2007). Therefore, understanding ethnobotanical knowledge is crucial to many community-based conservation programs.

In order to understand local ethnobotanical knowledge, and thus natural resource use, researchers often rely on two theoretical assumptions to justify minimalist sampling strategies, which focus on the oldest community members (Martin 1995). First, the community consensus model of ethnobotanical knowledge states that while each individual rarely possesses all local ethnobotanical knowledge, each community member is part of one homogeneous whole that is the local ethnobotanical knowledge (Reyes-Garcia et al. 2007b). Secondly, researchers have demonstrated that ethnobotanical knowledge increases with an individual's age and length of

residence, as well as the length of a community's continual residence. These correlations together with a community consensus model predict that if a researcher surveys enough of the oldest (most knowledgeable) community members, then the information gathered will reach a saturation point. This saturation point then represents the community consensus of knowledge. Recent studies focused on gender bias in ethnobotanical knowledge, challenge the community consensus model, and suggest that ethnobotanical knowledge is distributed unevenly within a community (Voeks and Leony 2004; Voeks 2007; Dan Guimbo et al. 2011). Pfeiffer and Butz (2005) demonstrate that in regions where women primarily marry outside of their natal village, they are not considered long-term local residents and are overlooked in such sampling strategies. When strategic inclusion of women is a priority, researchers find that women have qualitatively and quantitatively different ethnobotanical knowledge (Pfeiffer and Butz 2005; Voeks 2007; Dan Guimbo et al. 2011). Despite this evidence of heterogeneity in ethnobotanical knowledge, rigorous and exhaustive engagement strategies are still rare (Reyes-Garcia et al. 2007b). The absence of consideration of local knowledge heterogeneity brings us back to the question of the establishment and authenticity of community representation in such conservation programs that include local ecological knowledge (Kalland 2000).

To address these challenges of community representation, we wanted to examine both the how and why of stakeholder engagement: how one might discern which stakeholder groups are present within a community and why this might be important in the understanding of local ethnobotanical knowledge. It has been shown that local

stakeholder engagement early in the research process increases participation success (Reed 2008; Reed et al. 2008). So, rather than using literature on heterogeneity of ethnobotanical knowledge or researcher-driven stakeholder analysis techniques, we employed qualitative participatory research methods to allow stakeholders to self-identify key sources of heterogeneity. Then, we employed quantitative participatory research methods to examine the distribution of ethnobotanical knowledge across these locally defined groups.

Study Site

For this research we worked with a community living in and around the town of Boumba, Niger on the edge of the tri-national park, Park W (Fig. 1). Boumba hosts a locally and regionally important flora and fauna, due to the Niger River to the south, the Boboye wetland to the north, and a slightly elevated annual rainfall. Recent changes in Park W conservation strategy led by the EU-funded conservation and development programs have promoted community-based conservation initiatives within Boumba and other park border towns. The success of local community conservation efforts depends on the programs' alignment with the community's needs, wants, and skill sets (Müller and Guimbo 2011).

The community of Boumba with roughly 500–1000 residents has a recorded cultural history that dates back over 400 years leading to a diverse mix of shared-resource users (Mueller 2009). The residents of the Boumba village and its affiliated settlements represent a mix of ethnicity, gender, age, and education. All of these factors mediate ethnobotanical

Fig. 1 Map of study site: the study area located in southwest Niger. The enlarged region shows the placement Boumba (green circle), in relationship to Park W (blue), the Niger River (blue dotted line), and the Niger–Benin Border (image from Paulson Priebe and Müller 2013)

knowledge and value systems (Reyes-Garcia et al. 2007b). Ethnically, the main Boumba village is predominately a Zarma farming community. However, affiliated settlements both inside and outside the village contain minority populations of Fulani semi-nomadic herders and Hausa fisherman, traders, hunters, or butchers. Local custom, religion, and culture constrain the education and employment opportunities available to women such that specific “female” natural resources often become the sole source of income for many village women (Muller 2007). High local birth rates and low life expectancy also shape local age demographics and labor patterns.

Constant within this rural environment is the economic reality that residents must use natural resources to build and diversify their livelihoods (Dan Guimbo et al. 2007; Muller and Almedom 2008). Earlier research suggests that community members employ detailed ethnobotanical knowledge to exploit local plants to supplement their diet (Muller and Almedom 2008; Muller and Dan Guimbo 2008), provide for their animals (Dan Guimbo et al. 2011), and treat minor to severe maladies (Dan Guimbo et al. 2011). However, ethnic, gender, and age-based divisions of labor and responsibility mean that village residents have unequal access to local natural resources and habitats (Muller 2007; Dan Guimbo et al. 2011). These divisions affect the transmission and distribution of botanical knowledge throughout the community (Dan Guimbo et al. 2011) and thus possibly the success of community-based conservation initiatives.

Collaboration and Ethics

In 2005, research authorization was received from the Nigerien Ministry of Secondary Education and Research and from the Institutional Review Board at Tufts University. These permits remained in good standing through the completion of the research in 2008. At the start and end of each extended stay in Boumba, the authors held meetings with village elders, women’s leaders, and conservation agents to discuss research plans and previous results and request permission to live and work in the community and document local botanical knowledge. Approval was granted from all village leaders, and the authors remained in good standing with village authorities throughout the duration of the study. Individuals who were interviewed or otherwise participated in research activities all gave verbal consent to participation.

MATERIALS AND METHODS

This study draws on ethnobotanical field research conducted in Boumba, Niger over a series of repeated visits by all three authors from 2005 to 2008 in Boumba, Niger. In

sum, the authors spent over 600 days during 30 site visits (some overlapping), to ensure that there were observations and data that pertained to every month of the year, with the most intense work conducted in the rainy seasons (July–October) at the height of plant diversity. Additionally, the authors all spoke local language and had additional experience in rural Niger outside the study period.

The research began in August 2005 with an initial rapid rural appraisal to establish the community stakeholder groups, conduct initial assessments of community resource use, and identify natural resources of local ethnobotanical and conservation importance (Mueller et al. 2010). The stakeholder analysis in 2005 was conducted originally to inform the larger ethnobotanical study, which was examining the ways local knowledge can inform global conservation initiatives (Mueller 2009). In 2006, the third author conducted an independent qualitative study of the patterns of ethnobotanical knowledge in the region (Dan Guimbo et al. 2011). This qualitative research led to the joint desire to have quantitative studies of these patterns of ethnobotanical knowledge within the community. From July to October 2008, the three authors collaborated to conduct a quantitative study on the variation of ethnobotanical knowledge across both genders and locally defined age classes. This study focused on three locally defined use categories—food, fodder, and medicine (Muller and Almedom 2008). These three categories were chosen from the 13 local categories of useful plants identified by Dan Guimbo (unpublished results), because previous qualitative research indicated that gender and age had strong effects on the local knowledge of these plants (Dan Guimbo et al. 2011). This paper presents the results of the stakeholder analysis conducted in 2005 and a photo-recognition survey conducted in 2008. Information gathered over the authors’ entire engagement with the community helped align the research protocol with local realities and needs, as well as interpret the results.

Stakeholder Analysis

In order to identify stakeholder groups, Almedom et al. (1997) identify three basic steps. First, define the boundaries of the study. Second, find out how many groups make up the whole. Third, identify which of these groups are relevant to your purpose. We used these principles to draft a series of focus group questions. Working within local leadership, we asked for names of key individuals working with plants to attend the focus groups and then, we recruited additional individuals door to door. Working with women and men separately, we had participants draw a map of their socio-ecological system (the area where they lived and relied upon for resources). This map served to both define the boundaries of the study and facilitate

further discussion. As members added resources to the map, we asked which groups of people collected, managed, or used these botanical resources. The focus group activities were facilitated by the first author alongside an experienced Nigerian facilitator from the region. Between focus group activities, the first author conducted interviews and market surveys of natural products to serve as discussion prompts in the group discussions.

Pictorial Tools

Starting August 2005, photos were taken of plants either mentioned in interviews and focus groups, or collected in vascular plant surveys. These pictures, taken initially to serve as vouchers for plant identification, were all laminated and brought back to the community on subsequent visits to be used as tools in participatory research methods. This set of laminated photo cards represented a majority of the local natural resources based on the botanical surveys conducted in the region (Mueller et al. 2010). The authors then selected seventy-five laminated photos cards depicting local plants that had been listed in interviews and observed to be used for human food, animal fodder, or medicine. We focused on these three use categories for three reasons. One, our interviews, observation, and vascular plant surveys indicated that there was a wide range of local plants used for each of these activities. Two, the plants used ranged from very common to rare on the landscape. Three, previous research indicated that these plants were used differently between different age and gender groups (Dan Guimbo et al. 2011). Once the pictures were selected, the photos were grouped by use category (25 per category) and piloted with a small number of men and women of all age groups to refine the protocol. These sets represented less than 75 unique species, as some plants were used in more than one category.

In order to reduce artifacts of the methods that stemmed from a difference in the ability to recognize the photo, rather than the plant featured in the photo, the photo tools were piloted with individuals whose plant knowledge was known to the authors. Additional pictures were taken to replace images that routinely seemed to cause problems.

Quantitative Data Collection

In order to quantify the range of variation between the stakeholder groups, the authors used a photo-recognition survey (Martin 1995, Fig. 2). After consent, participants would identify each plant in one of the three sets of 25 pictures either by name, use, or ecology (description of habitat or growth characteristics). The set of cards a participant would consider was rotated from participant to participant, and the use category was not identified for the participants. This

Fig. 2 This is a photo of Salifou Hassane, a local field assistant, (in foreground) with a local *samarya* woman (blue headscarf) working through a set of food plant cards. The woman holds the photo card under consideration in her hands, and the field assistant will take notes from the interview and keep track of which photos have been seen

helped to keep interviews independent, reduce artifacts of the test, as well as allow specific use recognition as another form of identification. For example, if a participant could identify that a plant can be used to make sauce without being told that it was an edible plant, this was taken as knowledge of the plant. Conversely, if the plant was recognized and named, but the use was unknown, this was still counted as a yes. In both cases, the inconsistencies were considered during analysis. Allowing participants to identify a plant by where it grows in the field—habitat—or by its time of flowering or soil preference—ecology—reduced the importance of the name as a means to identification allowing us to test individuals of different ethnic groups and languages. Previous research in the area has also demonstrated that often individuals, especially young participants, may know a plant without knowing its name (Dan Guimbo et al. 2011). For each of the three sets of 25 photos, we aimed to randomly select ten to fifteen participants per age-gender class to interview for a total of 180–270

participants. It was very difficult to employ standard random sampling techniques, instead we selected the location for interviews randomly, following protocols of standard vegetative survey methods, and then participants would be recruited from that immediate location. We varied the time of day and day of the week to improve the diversity of participants. We also supplemented the random surveys with directed surveys to ensure that we had enough participants in each age-gender class (see Muller 2007 for more information on types of sampling strategies employed). For example, due to the great abundance and eagerness of the youngest age groups, the randomized sampling strategies produced a sampling population that was initially heavily skewed to the youngest age classes. To counter this trend, we would leave the sampling location to directly invite elders nearby to participate. Similarly, we had to pre-select a few sample sites in order to ensure that minority ethnic groups were represented in the sampling of each age and gender group. We could not, however, separate out ethnic groups for data analysis as our sample sizes would be too small and the sampling strategies too divergent. We stopped the survey when we got to roughly 250 participants, which for a village estimated at 500–1000 inhabitants is a large portion of the population and to keep sampling would risk that the interviews could no longer be considered independent events.

Data Analysis

The results from the picture-recognition survey were tabulated within use categories and analyzed for effects of a participant's gender, age class, and the interaction thereof on the number of plants recognized using a two-way analysis of variance (ANOVA). Pairwise comparisons were made using a Tukey's adjustment. We performed a simple linear regression on the effect of a participant's self-reported age on number of plants he or she could identify.

These data were compiled and presented to village members to gain local insights and engage the community in critiquing and interpreting the results of our study. The second author spent another month in Boumba following the completion of the quantitative study to conduct a participatory observation, informal interviews, and market surveys (Martin 1995) designed to provide further qualitative information regarding natural resource use to aid the interpretation of the results.

RESULTS

Stakeholder Groups

The results of the stakeholder analysis identified six demographic groups based on age and gender and three

ethnic groups (Zarma, Hausa and Fulani). Zarmas are the largest ethnic group and were identified as specialists in edible leaves. Fulani herders were identified as specialists in plants for animal food and animal medicine, whereas Hausa fishermen were specialists in the riparian plant community and certain spiritual and medicinal plants.

After ethnicity, community discussions identified men and women as having specific spheres of knowledge in regard to medicinal plants, fodder for animals, grasses used for construction, and food plants. First indication of this divergence in knowledge was in the fact that specific men and women were often cited as specialists in different domains of ethnobotanical knowledge. However, the gender-differentiated ethnobotanical knowledge was most clearly illustrated in discussions of ethnobotanical practice or in discussions of particular resources. For example, when prompted to list pediatric medicinal plants, local men would respond generally at first and then follow with directives to ask women. In another example when asked about her participation in fodder collection, a local woman stated “No, my husband exists,” which in her mind explains that he is present, alive, and responsible for animal care.

The stakeholder analysis identified three socially defined age classes, which were important to resource harvest: youth—an unmarried individual (ca. 12–20 years old); *samarya*—an individual married, but not considered an elder (ca. 20–40 years old); and elder—ca. 40 years old or more.¹ The discussions never referred to age in numbers, only in reference to socially defined age classes. Focus group participants described elderly men and women as both being important healers and knowing medicinally important plants. The group discussions also identified *samarya* men as users and knowers of animal fodder and construction grasses. Although the discussions never listed youth as experts or individuals of unique knowledge, youth were listed as individuals of unique action. For example, participants would make statements such as: only children/youth eat that resource, and only children/youth tend goats or sell fodder plants at the market. These statements pointed to youth as a separate stakeholder group with unique natural resource use.

As we continued the study and observed how participants interacted with one another, these gender and

¹ These definitions are simplifications and the age ranges are estimates made by the author, not the community as generally social factors, such as marriage, age rank in family, and gender, indicate the transition from one age class to another, just as these social indicators will change the roles and responsibilities of the individual regarding resource use. Furthermore, gender influences the age of transition as women tend to marry on average 5–10 years younger than men. Also to note is that the lower bracket for youth is also created by the authors as this was what we as interviewers set as a lower limit guideline although reported ages were often lower than what we had estimated in allowing them to participate, although self-reported ages in general were unreliable in their own right.

social-age groups also upheld the common standards for stakeholder groups (ODA 1995)—the participants communicated freely with one another within the group, the level of knowledge was more consistent, and expected and group cohesion was high.

Distribution of Knowledge Between Genders

Gender had an inconsistent effect on the number of photos recognized between the three plant use categories (Table 1). There was no significant difference between the number of medicinal plants recognized in photos by men than by women ($p = 0.18$), however, their responses often differed qualitatively. Women recognized significantly more food plant photos than men ($p = 0.01$), but significantly less fodder plants than men ($p < 0.01$; Table 1). Qualitatively, women would offer more detailed

information regarding food plants, including recipes and harvesting instructions. In comparison, men often disregarded food as a use for plants in general.

Distribution of Knowledge Across Age Classes Versus Self-Reported Ages

Self-reported ages had a significant effect on the number of medicinal and fodder plants recognized in photos (Fig. 3), but socially defined age class had a significant effect on the number of plant photos recognized in all three use categories. The number of medicinal plants recognized in the photos increased with self-reported age ($p < 0.01$, Fig. 3),

Table 1 The mean number of photos recognized by participants of different genders or age class. Participants identified plants from a set of 25 pictures of plants, either medicinal, edible, or fodder. The identification could be made by name or clear description of its use or habitat. For each grouping, we report the sample size (N), the average (Mean), the standard error (Std E), as well as the results of the 2-way ANOVA test statistic (F value, p value) and pairwise comparisons with significant differences between groups indicated by different letters

Category	N	Mean	Std E	F value	p value	
Medicinal plants						
Youth	43	5.1	0.53	32.53	<0.01	a
Samarya	34	7.7	0.56			b
Elder	17	15	1.79			c
All women	46	8.3	0.85	1.8	0.18	A
All men	48	7.4	0.79			A
Gender and age-class interaction				2.16	0.12	
Total	94	7.8	5.6			
Food plants						
Youth	43	12.0	0.67	10.45	<0.01	a
Samarya	28	15.8	0.86			b
Elder	8	17.9	1.83			b
All women	43	15.0	0.81	6.74	0.01	A
All men	36	12.6	0.71			B
Gender and age-class interaction				2.74	0.07	
Total	79	13.9	5.0			
Fodder plants						
Youth	28	10.5	0.65	26.31	<0.01	a
Samarya	25	16.6	0.90			b
Elder	21	16.2	0.74			b
All women	37	12.8	0.61	14.41	<0.01	A
All men	37	15.5	0.88			B
Gender and age-class interaction				3.95	0.02	
Total	74	8.7	4.9			

Number of Photos recognized by Participants of different Self-Reported Age

Fig. 3 Number of plant photos recognized by participants of different reported ages. Participants identified plants from a set of 25 pictures of **a** medicinal plants (General Linear Model, $r^2 = 0.77$, $DF = 36$, $p < 0.01$), **b** fodder plants (General Linear Model, $r^2 = 0.67$, $DF = 33$, $p < 0.01$) or food plants (data not shown, GLM, $r^2 = 0.48$, $DF = 31$, $p = 0.14$). Participants identified plants by local name or clear description of its use or habitat. Ages were estimated by participants themselves and are only approximate

whereas the number of fodder plants recognized seemed to peak around 40 years of age ($p < 0.01$, Fig. 3). There was no significant effect on reported ages on the number of food plants that participants could recognize ($p = 0.14$, data not shown). In contrast, age class had a highly significant effect on the number of plant photos recognized in all three categories (Table 1). *Samarya* recognized significantly less medicinal plants than elders ($p < 0.01$, Table 1). Youth recognized significantly less plants than all other age classes in all plant categories (all $p < 0.02$, Table 1). Qualitatively, youth demonstrated unique knowledge; in the case of 1–2 plants in each category, youth identified these plants more consistently and rapidly than *samarya* or

elders of either gender. In discussions with the community regarding these results, adult participants claimed that “youth know nothing.” However, when questioned regarding the individual plants that youth did recognize faster, community members explained these inconsistencies by stating that only youth (children) eat those plants.

Distribution of Knowledge Across Age-Gender Groups

The strength of the effect of the interaction between gender and age class on the average number of plants recognized differed between the three use categories (Table 1). The interaction between gender and age class had a significant effect on the number of fodder plants participants identified ($p = 0.02$). Elder and *samarya* men recognized significantly more fodder plants than women of the same age class ($p < 0.01$), but there was no difference in the number of plants recognized by young men and women ($p > 0.05$, Fig. 4). The interaction between gender and age class had a marginally significant effect on the average number of food plants participants recognized ($p = 0.07$). Overall, there appeared to be a trend for women to recognize more food plants compared to men in the same age class, but this was only significant with the elder age class ($p < 0.05$, Fig. 5). In addition, there was a trend for women participants to recognize more food plants with each change in social-age class ($p < 0.01$, Fig. 5). Within medicinal plants, the interaction between gender and age class was not significant ($p = 0.12$), meaning age primarily explained the differences between the respondents’ medicinal plant knowledge. Although in pairwise comparison, elder women recognized more medicinal plants than all other groups, including elder men (Fig. 6).

Fig. 4 The mean number of fodder plant photos recognized by participants of different gender–age demographics. Participants identified plants from a set of 25 pictures of fodder plants, either by name or clear description of its use or habitat. The number of participants is indicated on the *column*, and significant differences between groups are indicated by *different letters* (ANOVA, $r^2 = 0.52$, $p < 0.01$, $N = 74$)

Fig. 5 The mean number of food plant photos recognized by participants of different gender–age classes. Participants identified plants from a set of 25 pictures of food plants, either by name or clear description of its use or habitat. The number of participants is indicated on the *column*, and significant results are indicated by *different letters* (ANOVA, $r^2 = 0.312$, $p < 0.01$, $N = 78$)

Fig. 6 The mean number of photos recognized by participants of different gender–age demographics. Participants identified plants from a set of 25 pictures of medicinal plants, either by name or clear description of its use or habitat. The number of participants is indicated on the *column*, and significant differences between groups are indicated by *different letters* (ANOVA, $r^2 = 0.42$, $p < 0.01$, $N = 94$)

DISCUSSION

To address the question of how one might discern which stakeholder groups are present within a community, this paper focused on the ability of a participatory stakeholder analysis to enable stakeholders to identify key sources of heterogeneity. To examine the ability of the participatory methods for stakeholder analysis, we want to reflect on both the success and the challenges of these methods.

The participatory process quickly and efficiently identified demographic and ethnic groups that had been overlooked in the original project plan. Together, a trained local facilitator, a single outside researcher, and community members identified six demographic groups and three ethnic groups relevant to natural resource use in the region. These demographic groups upheld the standards of cohesion and equality necessary to strong stakeholder groups (ODA 1995). Furthermore, these stakeholder groups would not have been dictated by standard ethnobotanical protocols, because they included both genders, socially informed age classes, as well as multiple ethnicities.

There were, however, several challenges that needed to be addressed during the research process. First, although the lead author had 3 years of experience in the region and spoke local language prior to starting this research, the importance of the facilitator in leading discussion and decoding information received in the discussions cannot be understated. Initially, direct questions regarding ethnobotanical knowledge almost inevitably led only to the specialist healers in the community. Although as a research team we were interested in broad spectrum of plant use to understand local pressures on the environment, all of the initial key informants were specialists in medicinal plants. It was only through repeated questions on the variety of plant uses that we were able to uncover all of the stakeholder groups. For successful focus groups, facilitators must be able to understand what responses they are getting and what they are not getting in order keep discussions moving. This requires both knowledge of the local culture and the research questions. Researchers who do not have strong linguistic or cultural ties to the community themselves need to build a strong collaboration with local researchers. Despite the lead author's prior knowledge of the region, it was a strong collaboration with students and faculty at the local university and managers in the field that enabled the success of this research and these methods.

The other great challenge that needed to be addressed and overcome was the matter of matching community expectations to research limitations. For example, ethnicity was cited during community discussions as an important influence on ethnobotanical knowledge, but we could not analyze these data separately because of small sample sizes

and divergent sampling protocol. This decision was initially not communicated to the community until the presentation of results, at which time some community members noticed the omission of Fulani respondents in the presentation and felt that their suggestions had not been heard. Once we explained that in fact Fulani residents were indeed interviewed, the concerns subsided. This, however, raises issues as to how conflicts between the community members' requests and research limitations are resolved. If left unaddressed, this could have undermined local engagement, as it originally appeared that we were not acting on the advice of the community. By addressing this issue, we not only kept the community engaged, but also unveiled other misconceptions of the research that could be addressed. This iterative nature of the participatory process follows participatory research theory, which states community engagement must be both early and sustained throughout the research process (Almedom et al. 1997; Reed 2008; Mueller 2009).

At this point, we return to our second research question: why this participatory stakeholder analysis might be important in the understanding of local ethnobotanical knowledge. For this paper, we employed quantitative participatory research methods to examine the distribution of knowledge across these locally defined groups. Considering all three use categories, we ask how systematic and representative stakeholder engagement changes our perceptions of the community's ethnobotanical knowledge. Superficially, these results show both gender and age had an effect on the average number of plants respondents recognized with knowledge increasing with age and diverging with gender. Careful examination reveals a heterogeneous use-dependent knowledge that can be best captured through strategic engagement programs. The theory that underlies age-based sampling generally states that knowledge increases with age in some linear relationship. The results of the medicinal plants self-reported age-based analysis (Fig. 3) show the pattern of a linear increase, however, when examined within the socially defined age-gender classes the pattern shifts. Instead of a linear increase, the analysis of the age-based categories seemed to show a sharp threshold between elders and the rest of the community (Fig. 4). This was upheld qualitatively, as well. Elder participants were able to describe the specifics of the remedy and were more likely to list medicine as a use or reason for conservation. The step between *samarya* women and elder women was the largest increase among single factor changes, with a difference in means of over 10 plants, and the mean difference between youth and *samarya* participants was among the smallest. In literature, this sort of threshold between elders and the rest of the community is often interpreted as an erosion of ethnobotanical knowledge (Voeks and Leony 2004). Community

members may not be relying on traditional medicine, and so, the younger generations are not learning these plants. Our observations, however, did not seem to support this interpretation. Instead, our observations and qualitative data seem to point to the important role elders play in local healing practices. Locally, elders are expected to know about healing plants and many craft their responses to demonstrate their expertise. In field surveys, elder participants overemphasized medicinal uses, often stating that common edibles have no use. In contrast, as younger participants are not expected to have medicinal plant knowledge, they have not yet started learning this, or perhaps they simply might not offer it. Indeed, in some cultures, medicinal learning is very sacred and may only be passed down to individuals at selective moments in times. Although in this case the reason for the threshold between the elders and the lower groups cannot be exclusively determined, it seems clear that elder participants recognized more medicinal plants, not simply because they are 1 year older, but because they are locally engaged with the healing tradition. Furthermore, the difference between men and women among the elder category gives additional evidence of both age and social reality playing a factor in an individuals' ethnobotanical knowledge. In previous studies, examination of the qualitative differences between the medicinal plant knowledge of men and women in the region showed little overlap in the types of plants men and women listed as medicinal (Dan Guimbo et al. 2011). These results, while not over-turning age-based sampling, stress the importance of gender-aware sampling and bring into question the simple assumption that plant knowledge comes with age or long-term residence. Instead, these patterns support the idea that knowledge is acquired both through general life experience and socially constrained learning and experience.

In regard to fodder plants, the commonly used age-based sampling is challenged more directly. Elder participants did not demonstrate the most knowledge about fodder plants. When examining the self-reported ages, knowledge seemed to peak between participants aged 25 and 50 years old (Fig. 3). *Samarya* men and then elder men recognized the greatest number of fodder plants in pictures (Fig. 5), and *samarya* men in particular provided the most detail about these plants. This type of uni-modal relationship between age and local knowledge of plants is a similar pattern as Phillips et al. (1994) found for plants used in construction, which they explained by the important role that young men have in construction. Similarly, *samarya* men play a large role in animal husbandry and alongside the youth of both genders are the active practitioners of this knowledge. Indeed, previous studies in the area postulated an inverse relationship between age and knowledge of fodder plants, or a much younger peak in knowledge (Dan

Guimbo et al. 2011). This was not upheld in our study as there were no significant differences between *samarya* and elder participants both within gender (Fig. 5) or as a whole (Table 1). However, subsequent participant observation showed that youth were recognizing and gathering plants in the field that they did not name in pictures. There still seems to be artifacts of the tool that is contributing to low youth scores, despite our efforts to minimize the importance of knowing the plant name. Alternatively, the inability of youth to name plants in photos that they use in the field may be evidence that contradicts studies, which claim that factual knowledge, such as plant names, precedes practical knowledge such as recipes or harvest strategies (Ohmagari and Berkes 1997; Reyes-Garcia et al. 2007a). In our study, we observed that youth were using, collecting, and sometimes managing plants that they could not name for the researcher, or recognize in photos. Conversely, careful review of the interview notes indicated that the pictures of fodder plants, which were recognized by older women rather than younger women, were often identified as medicinal or edible plants, rather than fodder plants. This observation combined with the challenges in measuring youth knowledge raises the question whether recognition or name identification truly represents effective botanical knowledge especially in the context of environmental management. If researchers are interested in documenting the loss of ethnobotanical knowledge, it may not be enough to measure plant recognition when recognition does not correlate with the ability to recognize plant uses or the technical knowledge required to use the plant. As Reyes-Garcia et al. (2007b) postulate, to understand transmission of ethnobotanical knowledge, researchers must look at the variation of types of knowledge and establish better protocols to capture this knowledge.

Despite these challenges, we were still able to detect the impact of important social constraints and life changes on the ethnobotanical knowledge of community residents. For example, boys and girls had similar knowledge of fodder plants (Fig. 5), as they generally had similar exposure to animal husbandry and would tend animals together. In contrast, married women are typically more tied to the home than their male counterparts and less involved in animal husbandry, which explains why the gender patterns diverge at the next age class, *samarya*. *Samarya* women did not recognize significantly more pictures than young women, yet did recognize significantly less than their age-class counterparts, *samarya* men (Fig. 5). *Samarya* men, who still frequently care for animals in the bush or fields and who are less tied to the home, recognized significantly more fodder plants than women of all age classes and young men (Fig. 5). While *samarya* men did not identify significantly more fodder plant pictures than elder men, the quantitative trend alongside the qualitative data shows that

elder knowledge may represent a remnant of what was learned in early adulthood.

In regard to food plants, the effects of gender and age class on the ethnobotanical knowledge of participants were weaker overall as this represents less specialized knowledge. Self-reported age did not have a significant effect on the average number of food plants recognized by participants (Fig. 3), although age class did. Elder women recognized significantly more plants than all men and also young women (Fig. 6). Both elder and *samarya* women demonstrated more detailed knowledge of edible plants than other participants—listing recipes and taste qualities alongside names. Although *samarya* women did not recognize significantly more plants than men of their peer group, many men recognized and could name the plant, but did not know that it was edible. Since food procurement and preparation are a life-long responsibility for most local women, they continue to gain and use ethnobotanical knowledge regarding food plants. The step-wise trend between women of different age classes is, therefore, expected. These differences would most likely be more pronounced in either free listing exercises or with a larger set of cards. In discussions of conservation priorities, women would cite food as a use for many of the medicinal and fodder plants as well. In other value-ranking exercises, women consistently cited palatability and calorie count as reasons for ranking one plant over another. Interestingly, food plants also seemed to be recognized more readily by youth participants. There were 1–2 plant species in every use category that youth recognized more readily than their adult counterparts. There were not enough of these plants in any one category to ever make youth appear to be a specialist; instead, this seemed to be a qualitative distinction. However, discussions of the results with the community revealed that the species that youth were recognizing faster were plants that only youth would eat. Because of the large number of youth in this region even if there are only a few plants that youth are harvesting or using independently of their parents, this pattern can have major implications on our understanding of local natural resource use.

For the purpose of engaging local knowledge holders in conservation or development actions, our results supported that men and women have different and separate spheres of botanical knowledge (Pfeiffer and Butz 2005; Voeks 2007; Dan Guimbo et al. 2011). While gender itself was one of the weaker predictors of ethnobotanical knowledge within a category, the patterns of knowledge between categories were greatly determined by gender. Men showed strength in fodder plants, women showed strength in food plants, and elders in medicinal plants. Ruddle (1993) argues that learning processes are institutionalized to promote segregated knowledge patterns, and the patterns of knowledge

reflect both the current activities of the individual but also the institutional patterns of knowledge transmission. This segregated knowledge pattern that Ruddle describes is supported by our research. If ignored, this pattern will affect our ability to explain community-level behavior and change our understanding of local botanical knowledge and resource use. In almost perfect echo of the patterns we were seeing in photo recognition, our field participants were demonstrating these differences in the plants that they chose to bring home with them. When in the field, elder men almost exclusively brought home medicine for arthritis, and the younger men brought home fodder plants. Women regardless of age brought home food plants, and the elderly women brought home medicine for newborn care in addition to the food plants. Youth were observed daily passing the time while tending goats by eating sweet grass, finding wild fruit, weaving crafts, or otherwise entertaining themselves with the natural resources that surrounded them.

CONCLUSION

These results support previous calls for more detailed analyses of individual ethnobotanical knowledge patterns (Pfeiffer and Butz 2005). Furthermore, while these results cannot prescribe a set of stakeholder groups that will work in every project or in every community, they demonstrate a process by which researchers and managers can better understand the community in which they work. By engaging local residents in the process of defining the important stakeholder groups, the authors were able to redirect their community engagement strategy within the first month of the project. Although this study did not reject the idea that residents gain ethnobotanical knowledge with age, it suggests that there can be both moments of accelerated and arrested learning, which correlate with social events and norms. These experiences can have a greater impact on individual botanical knowledge than 1 year of aging would predict and will change from culture to culture. It is thus important that we recognize how the community understands key life stages in order to best interpret the expected changes in ethnobotanical knowledge.

Furthermore, age alone does not explain all of the patterns of ethnobotanical knowledge in this community, and more attention needs to be paid to the interplay of age and gender within the society. These nuanced patterns of knowledge across simple demographic factors argue for a careful examination of the assumptions underlying conservation policies especially programs promoting the sustainable use of natural resources. Most conservation policies are formulated at the state or national level. Diversity increases at each successive scale. Therefore misinformation at a community scale is

magnified in regional and national programming. Effective community-based natural resource management programs must be based on a true representation of the diversity of the local community's resource needs, environmental values, and institutional limitations. It is critical that assessment plans seek to strategically investigate the diversity inherent to each community, if we are to understand the needs of a community and truly gather community-wide support. Beyond age, gender, and ethnicity, there are many factors that create diversity in communities and predict heterogeneity in ethnobotanical knowledge. But even with this simplified view of diversity, we were able to detect patterns of ethnobotanical knowledge that, if ignored, could undermine the effectiveness of a natural resource management program. This study found that youth were using plants that they could not identify, women were prioritizing plants differently than men, while older participants overrepresented the importance of medicinal plants. All of these results indicate that if a policy maker were to come into the region and only survey men or only survey elders, they might derive a false impression of the needs of the community and the level of pressure that this community puts on its natural resources. As we move up to the global scale, the error is magnified and our understanding of how societies use and value natural resources becomes unable to explain the patterns of socio-ecological diversity around us. This paper demonstrates a solution to this problem in the process of local engagement at the onset of program to allow communities to identify their own diversity and thereby prescribe engagement strategies.

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