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Niche breadth and redundancy: Useful indices to analyse fuelwood use in rural communities

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ABSTRACT

In this work, the concepts of niche breadth and redundancy were used to analyse the use of fuelwood species in rural populations in Patagonia, Argentina. We conducted semi-structured interviews to estimate the fuel niche breadth (FNB). For this, the variables used were as follows: use consensus of native species, use consensus of preferred species and use consensus of pruning species. Moreover, two indices were created to compare socio-environmental fuel redundancy and economic dependence between populations. The most isolated population presented the highest values for FNB, considering principally the use consensus of native species and high environmental redundancy, while the community with most access to urban centres showed the highest FNB value for use consensus of pruning species. The third community presented intermediate values for FNB and low levels of redundancy, showing notable vulnerability. The FNB measured through fuelwood use contributes to the description of socio-ecological factors. Evaluation of redundancy in terms of a resource and its different functional varieties, while not focusing in particular on the functionality of the species, allows the evaluation of the current situation of the resource under study. The indices created in this work can also be used for other variables related to subsistence lifestyles.

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1. Introduction

From an interdisciplinary perspective such as ethnobiology, it is understood that the knowledge and use of natural resources by traditional communities depends on the type of environment and the cultural and socio-economic characteristics of each population (Berkes et al., 2000; Varela, 2000).

Interaction between populations and their surroundings is dynamic because of spatial and temporal changes such that in certain contexts of scarcity, the environments offer resources that are relevant to the human populations that depend on them for their subsistence (Berkes, 2008; Hunn, 2014). It is therefore important to value these resources according to the perception of those who use them to understand how changes in their availability influence inhabitants' everyday lives, in both social and ecological terms (Berkes, 2008).

The classical works of Hardesty (1972, 1975) have made an invaluable contribution to studies on the relationship between human beings and the use of natural resources, focusing on the concept of niche breadth as a useful tool for the comparative evaluation of how populations use the elements in their surroundings with varying intensity. This concept includes the idea of multidimensionality, i.e. various dimensions may be analysed in the study of resource use or one particular dimension may be analysed over a certain period of time (Hardesty, 1972, 1975). A community will present higher niche breadth if they display greater diversity or evenness in the use of the dimensions analysed, whereas communities with the dimension of the most selective resource will present narrower niche breadth (Hardesty, 1972, 1975). Certain ethnobiological approaches have used this concept to analyse the use of resources associated with the food dimension (Begossi and Richerson, 1993; Hanazaki and Begossi, 2000; Branco do Nascimento et al., 2010), revealing, for example, that when wild resources are scarce, niche breadth increases, particularly when populations can access external resources (Begossi and Richerson, 1993; Hanazaki and Begossi, 2000; Da Silva and Begossi, 2009).

In addition to this, the concept of ecological redundancy has been evaluated in several ethnobiological studies where various

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species may be used for the same function in a socio-ecological system. This has been researched mainly in traditional medicine systems (Borba Nascimento et al., 2015; Soares Ferreira Júnior et al., 2011; Richeri et al., 2013). Currently the relevance of considering the redundancy of certain socio-ecological systems is being evaluated through the utilitarian redundancy model (URM) to study functional systems and generate integrated conservation and biocultural management strategies (Borba Nascimento et al., 2015). However, these strategies have not yet been applied in the study of fuel resources.

Some investigations have analysed the use of wild fuel resources in populations inhabiting hostile environments (Sá e Silva et al., 2008; Cardoso et al., 2012, 2013) and have focused on identifying either new practices developed to compensate for fuelwood scarcity (Jashimuddin et al., 2006) or the physical combustion properties of the woods, which lead to a preference for their use (Abbot et al., 1997; Ramos et al., 2008; Cardoso et al., 2015). It is therefore interesting to analyse the relation between rural subsistence populations and fuel redundancy as a measure of this vital component, which is essential mainly for heating and cooking (Ramos et al., 2008; Cardoso et al., 2012, 2013).

To date, no studies that integrate the concept of niche breadth with the use and consumption of fuel plants have been executed. Moreover, the concept of functional redundancy has not been analysed in relation to woody resources. The rural steppe communities of northwest Patagonia have traditionally farmed sheep and goats for a living, in conjunction with the gathering of wild edible, medicinal, and fuelwood plants and small-scale horticulture (Ladio and Lozada, 2004; Molares and Ladio, 2012; Cardoso et al., 2012; Eyssartier et al., 2013). Fuelwood gathering is practically a daily exercise, and it is directed mainly to bushy species of the predominantly arid environments to the east of the Andean cordillera. This natural resource is complemented with the purchase of firewood of external origin (Cardoso and Ladio, 2011; Cardoso et al., 2012, 2013). It has been documented that populations that share similar ecological environments present higher similarities in their subsistence practices than populations settled in different environments (Ladio and Lozada, 2001; Ladio et al., 2007). Thereby, it is interesting to evaluate fuel niche breadth amongst communities of Mapuche ancestry, considering their use and management of fuelwood resources as the main dimension of analysis. Furthermore, the evaluation of fuel redundancy will offer another perspective, contributing to the understanding of niche breadth and comparison between populations.

The general objective of this work is to analyse how fuel niche breadth, i.e. combustible plant use, varies between neighbouring rural populations in an arid region of northeast Patagonia. The communities of Pilquiniyeu del Limay, Laguna Blanca and Comallo have the same cultural roots but differ in other aspects such as the presence of woody plants in their immediate surroundings and relative access to urban centres. Our study focuses mainly on the quantitative analysis of the woody species, but socio-economic aspects are also assessed. The data were recorded using the ethnographic methodology, which is widely used to estimate qualitative and quantitative results obtained through interviews (Guber, 2001, 2004); methods of specific plant sampling were therefore not used.

The study of an essential resource like woody species allows us to estimate, in a relative way, the current situation of these populations in their environment. We hypothesise that (1) even though the populations are close in geographical terms and share a subsistence way of life in an arid region, the relative richness of available woody species will lead to differences in the use of fuel resources and therefore variance in the fuel niche breadth; (2) the most isolated communities, which are located in less anthropised environments, with a higher offer of wild resources will present greater socio-environmental redundancy; (3) communities with more access to urban centres will use a higher diversity of biofuel resources, which is associated with greater availability of external resources and economic dependence.

2. Methods

2.1. Study area

The study was implemented in the northwest of Patagonia, Argentina, in three rural communities lying in the last foothills of the Andean Cordillera, from west to east, in an ecotone and Patagonian steppe zone (León et al., 1998). The communities involved were Pilquiniyeu del Limay (250 inhabitants) (40° 31′ S and 70° 02′ W; 898 m.a.s.l.), belonging to the Monte-Patagonia ecotone region where shrub-steppe vegetation predominates; Laguna Blanca (180 inhabitants) (40° 43′ S and 69° 50′ W; 1251 m.a.s.l.), situated to the west in a shrub-steppe region that borders a zone of uncultivated land; and Comallo (2000 inhabitants) (41° 02′ S and 70° 16′ W; 782 m.a.s.l.), situated in a grass-shrub steppe region (León et al., 1998) (Appendix 1 version electronic only, Table 1). The landscape is distinguished by its valleys, wetlands and rocky outcrops. The climate is predominantly arid and cold, with annual precipitation of between 150 and 300 mm, which is concentrated in autumn and winter as rain and snow, and the average annual temperature is 8–10 °C (Bran et al., 2000).

These populations are made up of peasants of Mapuche ancestry who speak the dominant Spanish language; very few speak the native Mapuzungun. The principal economic activity is sheep and goat farming for the sale of wool and family sustenance. The women do craft work with the wool, and these products are sold in regional markets (Cardoso et al., 2012, 2013).

The closest urban centre to these communities in northwest Patagonia is the city of San Carlos de Bariloche (130.000 inhabitants) at a distance of approximately 220 km. In all cases, the families depend on fuelwood for cooking and heating their homes, and fuelwood gathering is generally carried out on foot or horseback. The main differences between these populations are presented in Table 1.

2.2. Data collection

Fieldwork was executed according to the guidelines presented in the Code of Ethics of the International Society of Ethnobiology (ISE, 2006). During the years 2011 and 2012, visits were made to each of the communities and the interviewees' homes. In this case, the ethnographical methodology consisted in contextualised dialogue with each of the families visited, each one being taken as a sampling unit. Semi-structured interviews, free listing and participant observation (Guber, 2001, 2004) were carried out. The semi-structured interviews were based on an open questionnaire. Free listing involved a question being asked and the interviewee responding by giving all possible answers. For participant observation, the researcher spent time with members of the community in an everyday context. During this shared time, the researcher interacted with the interviewee and recorded the activities carried out.

Twenty-eight inhabitants were interviewed in the Laguna Blanca community, 35 in Comallo and 28 in Pilquiniyeu del Limay. An individual from each domestic unit was interviewed. Questions were related mainly to the use of domestic firewood; the phenomenon of the interviewee's perception of their surroundings and

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