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When lessons from population models and local ecological knowledge coincide – Effects of flower stalk harvesting in the Brazilian savanna

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ABSTRACT

Sustainable harvest of non-timber forest products (NTFPs) can play an important role in biodiversity conservation and livelihoods. However, harvesting policy intended to promote conservation are frequently either ineffective or too complicated. Successful policies should consider ecological impacts, local ecological knowledge and management practices, but NTFP policies are rarely based on these elements. *Syngonanthus nitens* (Eriocaulaceae, 'golden-grass') is one of the most valuable NTFPs from the Brazilian savanna. The handicrafts made from this species' flower stalks are traditional to the Jalapão region, Tocantins state, but have expanded over a much larger area in recent years. We combined ethnoecological interviews, seed phenology surveys over a large geographical area and harvest experiments in nine sites over 3 years to assess local ecological knowledge and management of golden-grass and its long-term effects on population dynamics. Although handicrafting activities are rapidly expanding, local ecological knowledge associated with harvest or management has not been transferred or created outside of Jalapão. Matrix population models illustrate that harvest according to traditional management practices had no impact on golden-grass population dynamics. Earlier harvest of golden-grass, as practiced by new artisans, leads to population decline due to plant uprooting. Local policies for golden-grass harvest are consistent with traditional management, limit the timing but not the quantity of harvest, and are appropriate over a wide geographical scale. Golden-grass and other wild harvested species with similar characteristics hold high potential to help conserve threatened habitat.

1. Introduction

The extraction of non-timber forest products (NTFPs) has been regarded as an alternative for sustainable development with much enthusiasm as well as criticism over the past three decades (Belcher and Schreckenberg, 2007). For NTFPs to improve local livelihoods and promote conservation, it is essential to identify management and marketing practices that minimize ecological impacts and increase revenues (Varghese and Ticktin, 2008). Many public policies regarding NTFP harvest, although developed with good intentions, require high technical expertise and/or economic investments, and therefore frequently fail to be implemented effectively by local communities. Inappropriate regulations can generate conflicts and instigate unsustainable resource exploitation. Successful regulations can only be implemented by considering both ecological impacts, and local ecological knowledge and management practices (Laird et al., 2010). However, policy for few NTFPs is actually based on both elements.

Local ecological knowledge and the traditional management practices derived from it are developed over time as a result of observation, as well as from trial and error processes. They are passed down by individuals and communities (Berkes, 2008) and can affect NTFP harvest sustainability (Varghese and Ticktin, 2008) and yield (Ticktin and Johns, 2002). Local ecological knowledge and traditional management may vary widely among communities across a landscape (Gaoue and Ticktin, 2010; Ghimire et al., 2008; Varghese and Ticktin, 2008). When the commercial sale of NTFPs expands to areas without a history of use, and local ecological knowledge and management is not transferred, adapted or newly developed, this can pose challenges for sustainable harvest (Ticktin and Johns, 2002). However, if and how local ecological knowledge spreads is rarely considered. In addition, although many NTFPs are harvested over large geographical scales, most studies on harvesting impacts are geographically restricted (Ticktin, 2004).

Matrix population models (Caswell, 2001) are frequently applied to assess NTFP harvest impacts (see review by Schmidt et al. (2011)). By assessing long-term population growth rates

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(lambda, λ), and carrying out prospective (sensitivity and elasticity analysis) and retrospective analyses (life table response experiments, LTREs) it is possible to identify the effects of harvest on plant populations. Previous research has illustrated that the harvest of reproductive structures, including propagules and flowers, usually has a low impact on the population dynamics of perennial species (Emanuel et al., 2005; Lamont et al., 2001; Ticktin, 2004). Conversely, harvest that increases adult mortality can severely decrease population growth rates of plants (e.g., Soehartono and Newton, 2001), including perennial herbs (e.g., Ghimire et al., 2008; Law, 2007). However, most matrix model studies of NTFPs lack comparisons between populations under different harvesting levels (Schmidt et al., 2011), which limits their use in designing management plans. In addition, very little information is available on the impacts of harvesting tropical herbs, regardless of the plant-part harvested (but see Jimenez-Valdes et al., 2010; Ticktin and Johns, 2002).

The sustainable use of NTFPs has the potential to be an important conservation strategy in the Brazilian savanna, the Cerrado, a biodiversity hotspot where 80% of the original vegetation has been disturbed or converted to large pastures and monocultures, and less than 3% is inside protected areas (Klink and Machado, 2005). *Syngonanthus nitens* (Bong.) Ruhland (Eriocaulaceae), known as 'golden-grass' *capim-dourado*), is a highly valuable NTFP that occurs throughout the Cerrado but is especially harvested in the Jalapão region in Tocantins state, where it has represented the main income source for hundreds of families since the late 1990s (Schmidt et al., 2007). This perennial herb's bright flower stalks are sewed with buriti palm (*Mauritia flexuosa*) young-leaf strips to make handicrafts, including basketry and jewelry (Sampaio et al., 2008).

Local ecological knowledge from one community in Jalapão that has the longest history of handicrafting (*Mumbuca*), maintains that golden-grass should only be harvested 'late' – after mid-September, when flower stalks are bright and dry ('ripe') – since this prevents plant uprooting during harvest and increases handicraft brightness. This traditional management practice, although not directly based on concern for seed production, coincides with seed production phenology, and prevents negative impacts of harvesting on individual survival and reproduction (Schmidt et al., 2007). After a long negotiation process with about a dozen Jalapão communities, the Tocantins environmental agency, *Naturatins*, established formal harvesting regulations for the Jalapão region in 2004 based on traditional management and data on seed production phenology from a 1-year study (Schmidt et al., 2008). The regulations state that (i) harvest can only be performed after September 20th, when flower stalks are dry and seeds have been produced; (ii) flowerheads must be cut and dispersed in gathering areas just after harvesting; (iii) only harvesters who register with Naturatins are allowed to harvest.

However, since the 2000s, golden-grass handicrafting has expanded to new regions of the Cerrado, and therefore into communities with no previous experience harvesting this species. Due to the increased harvesting pressure, the government harvest regulations for the Jalapão region were extended to the whole state in 2007 (Portaria-Naturatins 362/2007). This expansion of the regulations was not based on ecological research or local knowledge, and upset some harvesters, who maintain that golden-grass flowering periods vary across the state, so that one state-wide rule is not appropriate.

We used a combination of ethnoecological interviews, matrix population models and regional surveys of golden-grass seed production to assess the potential for sustainable harvest of golden-grass flower stalks. Specifically we addressed the following questions: (1) Have the local ecological knowledge and management practices from Jalapão been passed onto new harvesters and/or has new local ecological knowledge developed? (2) What are the effects of Jalapão traditional management ('late' harvest) on golden-grass population dynamics? (3) What are the potential effects of earlier harvesting of flower stalks on golden-grass population dynamics?

2. Methods

2.1. Study region – Tocantins state and the Jalapão region in the Brazilian savanna context

The Cerrado is the second largest biome in Brazil and originally occupied more than two million km^2 (Furley, 2004; Oliveira and Marquis, 2002). Tocantins state has large conserved areas both inside and outside of protected areas and plays an important role in conservation of the Cerrado. Within this state, the Jalapão region is one of the best conserved areas in the Cerrado (Silva and Bates, 2002). Most of golden-grass handicrafting takes place in the core of Jalapão region in the municipalities of Mateiros and São Félix. Jalapão human population density is low (<1 inhabitant/km^2), the local economy is based on subsistence agriculture, extensive cattle raising (Seplam, 2003), and recently, tourism and golden-grass handicrafts. The Cerrado rainfall is highly seasonal; mean rainfall in Jalapão is 1700 mm, 90% of which falls between October and April, and mean annual temperature is 27 °C (Seplam, 2003).

2.2. Study species

Golden-grass is a clonal, polycarpic, perennial rosette-forming herb that grows to about 4 cm in diameter (Giulietti et al., 1996). Flowering occurs once a year from July to August, with each plant producing 1–10 flower stalks, with a capitulum flower (or flowerhead). Flowerheads bear 30–60 wind-dispersed seeds, each about 0.9 mm long. Seed germination rates in laboratory conditions are high (>85%, Schmidt et al., 2008); seeds retain viability for less than 1 year in the laboratory and field conditions (Schmidt, 2011).

Golden-grass occurs in wet grasslands, on organosoils with high plant diversity and endemism (Munhoz and Felfili, 2006). In Jalapão, local harvesters set fire to wet grasslands during the dry season to promote golden-grass flowering in the following dry season. Fire is also used to promote resprouting of native grasses for cattle. The present, anthropogenic, fire return interval in Jalapão wet grasslands is 2–3 years (Schmidt et al., 2007). Although it has not been investigated in the Jalapão region specifically, the natural fire return in the Cerrado may vary from 1 to 9 years, depending on the vegetation physiognomy (Miranda et al., 2010). Golden-grass is harvested from community-owned areas, private lands and protected areas. The land tenure system and presence of large, non-inhabited areas allow more than one community to manage the same areas, often generating conflicts related to fire and golden-grass management.

Golden-grass handicrafting began in Mumbuca community in the 1930s. By 2000, it had expanded to all of the core Jalapão region (Schmidt et al., 2007), becoming a trademark of the Jalapão, and even Tocantins state. Handicrafts are sold locally as well as in all the main Brazilian cities, and exported to several countries.

2.3. Assessing local ecological knowledge and management of golden-grass in Tocantins state

In June and July 2008, we visited communities in nine municipalities in Tocantins state, outside of Jalapão region, where golden-grass handicrafts have recently become economically important. In each community, we conducted semi-structured interviews and focus groups (up to 12 people) with artisans to ac-