



Subsistence use of papyrus is compatible with wetland bird conservation



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ABSTRACT

Conservationists have historically advocated measures that limit human disturbance. Nevertheless, natural disturbances are important components of many ecosystems and their associated species are often adapted to such regimes. In consequence, conservation managers frequently simulate natural disturbance, particularly in temperate forest systems. This practice is less widespread and seldom studied in tropical regions, where biodiversity conservation and human activities are often thought to conflict. However, many tropical systems have been subject to natural and anthropogenic disturbance over evolutionary timescales, and disturbance may therefore benefit the species they host. Determining whether this is true is especially important in tropical wetlands, where human activities are essential for sustaining local livelihoods. Here we investigate the impacts of disturbance from human resource use on habitat-specialist bird species endemic to papyrus swamps in East and Central Africa. Bird densities were estimated using point counts and related to levels of human activity using physical characteristics of wetland vegetation as a proxy for disturbance. All species were tolerant to some degree of disturbance, with particular species occurring at highest density in intensely disturbed habitat. Species were generally more tolerant to disturbance in larger swamps. Our results suggest that low-intensity use of papyrus wetlands by people is compatible with the conservation of specialist bird species, and highlight the potential benefits of traditional human activities to conserve biodiversity in the tropics.

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1. Introduction

Habitat degradation is one of the greatest threats to biodiversity (WWF, 2014) and restoring habitat is frequently the focus of conservation management (Hodgson et al., 2011). To this end, conservationists have advocated measures that limit disturbances caused by human activity, adopting the view that the needs and actions of people often conflict with the objectives of biological conservation (Brown, 2002). The classic “fences and fines” approach dominated much of the 20th century but has been criticized for its failure to account for the interests of communities by impeding the use of natural resources (Hutton et al., 2005). This is particularly problematic in developing countries (Barrett et al., 2001), where people’s livelihoods are closely linked to natural resource use (Khadka and Nepal, 2010). In consequence, conservation now often adopts a more community-based approach, which strengthens the link between conservation and human needs (Adams and Infield, 2003). These participatory methods incorporate a variety of incentives to make conservation more favourable to local communities (Spiteri and Nepalz, 2006). Nevertheless, community-based conservation schemes often restrict resource use (Lele et al., 2010), commonly with financial incentives (Barrett et al., 2001) and as such, maintain the premise that human activities are detrimental to biodiversity.

Many ecosystems have, however, been modified over very long periods of time. Thus, human disturbances potentially play a role in maintaining biodiversity (Hobbs and Huenneke, 1992), with many species having evolved under natural disturbance regimes prior to the influence of humans (Lindenmayer et al., 2008). The role of disturbance is recognised and incorporated into management programmes in various temperate systems (Bengtsson et al., 2000; Seymour et al., 2002). Forests, for example, were prehistorically grazed by megaherbivores, and subsequently by domestic animals following the regional extinction of large grazers (Bengtsson et al., 2000). Human-based disturbances which create early successional habitat, are used by forest managers to simulate natural forms of disturbance (Bengtsson et al., 2000; Lashley et al., 2014; Seymour et al., 2002). The extent to which disturbance is important for maintaining biodiversity has seldom been studied or considered in tropical areas; home to high levels of global biodiversity (Hillebrand, 2004), yet a rapidly growing human population and extreme poverty place increasing pressures on tropical societies, habitats and species (Hutton and Leader-Williams, 2003; Spiteri and Nepalz, 2006). Therefore, it is crucial to understand the extent to which populations of species can be sustained in human-modified landscapes and how specific land-use practices influence biodiversity (Chazdon et al., 2009).

Tropical wetland systems encapsulate the potential conflicts and synergies between human exploitation of natural resources and conservation; vital for human wellbeing (Senaratna Sellamuttu et al., 2011)

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and the alleviation of poverty, as well as hosting a rich biodiversity (Russi et al., 2013). In East Africa, papyrus (*Cyperus papyrus*) swamps support the livelihoods of millions of people through the provision of ecosystem goods and services (van Dam et al., 2014) including water, food, medicinal herbs, fishing and grazing habitat for livestock (Terer et al., 2012b). Papyrus is frequently harvested and used for roof and fence construction, and to craft items such as baskets, trays, sleeping mats and ropes, which provide basic resources and a vital source of income for rural poor communities living in close proximity to swamps (Maclean et al., 2003b). These swamps also host a unique biodiversity including a suite of generalist species of birds (Maclean et al., 2003a), alongside several species of specialist passerines (Britton, 1978; Vande weghe, 1981). In common with wetlands worldwide, papyrus swamps are increasingly threatened by habitat loss from drainage and encroachment for agriculture (Maclean et al., 2011b). As a result, population estimates of papyrus passerines suggest that they are decreasing in numbers, undergoing even greater declines than the habitat on which they depend (Maclean et al., 2013).

Disturbance from human activities in papyrus swamps has been considered detrimental to biodiversity and, in consequence, legislation in East Africa tends to impose restrictions on harvesting by local people (Hartter and Ryan, 2010; Wetlands Inspectorate Division, 2001). However, these restrictions can alienate local stakeholders and risk the success of further conservation efforts (Terer et al., 2012a). Disturbance from subsistence use, including harvesting for materials and burning from smoking bees out of hives or hunting game or fish (Maclean et al., 2006), has been ongoing for over a millennium (Terer et al., 2012b), and papyrus swamps have been exposed to natural forms of disturbance from fire and large herbivore grazing prior to human settlement (Taylor, 1990). Following the regional extinction of large herbivores, people are likely to have replaced the role of these natural forms of disturbance in maintaining a more open habitat through harvesting and burning (Maclean et al., 2006). As with forest systems, this history of disturbance could have implications for the way wetlands in sub-Saharan Africa should be managed.

Here, we investigate the effects of disturbance on a suite of habitat-specialist species as an exemplar of the potential impacts of subsistence resource use, from direct cutting and burning, by local people on biodiversity in the tropics. Specifically, we quantify the effects of varying levels of disturbance on the relative densities of specialist bird species in an area of south west Uganda. Habitat specialists are typically more sensitive to disturbance (Devictor et al., 2008). In consequence, if the densities of these birds are not negatively affected by disturbance, resource extraction to support local livelihoods is unlikely to be detrimental to birdlife, potentially to wildlife in general, and the long-term provision of ecosystem services. We conclude by discussing the implications of our findings for the conservation management of tropical wetlands and other habitats.

2. Material and methods

2.1. Study site

The study was conducted between May and June 2014 at Lake Bunyonyi, south west Uganda (01°17'S 29°55'E), to coincide with post-rainy season breeding (Britton, 1978). In this area, papyrus swamps persist along the lake shore and in valley bottoms, surrounded by heavily cultivated land. This region is subject to particularly high levels of disturbance from harvesting and burning as a result of increasingly high human populations (Maclean et al., 2011b) and levels of poverty (Gable et al., 2015), as well as hosting among the highest densities of papyrus endemic passerines (Maclean et al., 2011b). At Lake Bunyonyi, papyrus is most commonly harvested and sold in bundles to use as a source of fuel, for thatching roofs, constructing fences and occasionally creating small out-buildings (see Maclean et al., 2003b). Thin strips of papyrus are also cut and used on a smaller scale to make a variety of handcrafts used for domestic purposes, or sold locally,

increasingly to tourists (Maclean et al., 2003b). Small-scale burning in this area is largely caused by fishermen in an attempt to catch eels, which are marketed locally or used to feed families (J. Ruhakana pers. comm). Occasionally, burning can be initiated accidentally in an attempt to smoke bees out of hives while harvesting honey, often situated in the swamp interior distant from local communities (Maclean et al., 2006). These subsistence-based activities are more frequent during the dry season in Uganda, when income from crop production declines (Maclean et al., 2003b).

2.2. Study species

Research concentrated on five specialist species of passerines most closely associated with papyrus in the study area, which have global distributions centred around East and Central Africa (Maclean et al., 2013). White-winged scrub-warbler (*Bradypterus carpalis*), greater swamp warbler (*Acrocephalus rufescens*) and papyrus canary (*Serinus koliensis*) are entirely confined to papyrus, although papyrus canary often forages in adjacent cropland (Vande weghe, 1981). Papyrus yellow warbler (*Chloropeta gracilirostris*) and Carruthers's cisticola (*Cisticola carruthersi*) are primarily confined to papyrus, but can inhabit wetlands dominated by other types of vegetation, namely *Typha* and *Miscanthidium* spp. (Vande weghe, 1981). Carruthers's cisticola was also found to inhabit wetland recently converted to agriculture in this study. All species are currently listed as Least Concern on the International Union for Conservation of Nature (IUCN) Red List, with the exception of papyrus yellow warbler, which is classified as Vulnerable due to a small and fragmented population, suspected to be in decline owing to the exploitation of its habitat (IUCN, 2015).

2.3. Point count survey

105 point count surveys were conducted by the same observer between 7 am and 11:30 am, when the birds were most vocal. Swamps surveyed ranged in size from approximately 0.01 ha to 996 ha and covered the length of the lake (~35.6 km) (Fig. 1). A 1- to 2-min adjustment time was used prior to survey to minimise disturbance caused by arrival on-site. Numbers of focal bird species were identified visually or aurally within a 15-min period and the distance of each individual from the point of survey recorded within distance bands (0–19 m, 20–49 m, 50–99 m, 100–199 m). Each point covered a circular area with a 200 m radius, the location of which was recorded on GPS in the UTM (Universal Transverse Mercator) projection system. Counts were conducted from the edge of swamps often on higher land, offering an effective vantage point of both the edge and interior. Wetlands surveyed varied in size (mean size: papyrus swamp = 6.3 ha; broad wetland = 30.8 ha), thus multiple counts were conducted at opposing sides of large wetlands (diameter > 400 m²). Given the length of survey period and variation in area of swamp surveyed, data collected per count represent a relative, not absolute, indicator of species' abundance at each point (see Maclean et al., 2013, Maclean et al., 2011b, for population assessments across the region).

2.4. Disturbance estimation

For the purpose of this study, we concentrate on human disturbance from recent and past harvesting of papyrus wetlands, together with occasional recent burning. As stands of papyrus first regrow following disturbance, culm width decreases and density increases (Maclean et al., 2006; Muthuri et al., 1989; Terer et al., 2012b). Thus, disturbance can be efficiently measured visually, using physical characteristics as a reliable indicator of disturbance levels. Based on this, five vegetation categories were created and used as proxies for disturbance (Table 1). The dominant form of disturbance in our study area was harvesting. A small amount of recent burning was also recorded (within ~5% of point counts), which was combined with harvesting to represent high

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