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Does the protection status of wetlands safeguard diversity of macroinvertebrates and birds in southwestern Ethiopia?

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ABSTRACT

Freshwater ecosystems are highly threatened due to increased population growth, thereby affecting biodiversity. The objective of designating an area as 'protected' is to reduce habitat degradation and biodiversity loss. However, most protected areas focus on the conservation of the terrestrial environment and its related biodiversity. Little attention is given to the protection of freshwater biodiversity and consequently far less is known on how freshwater biodiversity differs between wetlands with a different protection status. The objectives of this study was to investigate alpha and beta diversity of macroinvertebrates and wetland dependent birds in wetlands with a different protection status and thus a different level of human impact in southwestern Ethiopia. Data on macroinvertebrates, birds, physico-chemical water quality, human disturbance and vegetation cover were collected from 42 sampling sites during dry and wet season of 2015. Besides the calculation of alpha and beta diversity, multiple regression models were used to identify the main drivers of the variation in beta diversity of macroinvertebrates and birds in these wetlands. Our results revealed that the average alpha diversity of both macroinvertebrates and wetland dependent birds was significantly higher in protected wetlands (low overall human disturbance) compared to unprotected wetlands (high overall human disturbance), whereas beta diversity was higher in unprotected wetlands for wetland dependent birds. Turnover contributed more than nestedeness to total beta diversity for both macroinvertebrates and wetland birds in protected and unprotected areas. Human disturbance, water temperature, pH and dissolved oxygen were significantly related to beta diversity of macroinvertebrates, whereas beta diversity of wetland dependent birds was significantly related to vegetation cover, nutrients and chemical oxygen demand. Conservationists should give attention to both alpha and beta diversity of freshwater wetlands in order to conserve wetland biodiversity maximally.

1. Introduction

Wetlands are recognized as a biodiversity hotspot, but are one of the most threatened ecosystems worldwide (Lavoie et al., 2016; Sica et al., 2016). Although freshwater wetlands cover only 1% of the earth's surface, they are a habitat for > 40% of the world's species (Mitra et al., 2003). Despite their ecosystem value, freshwater wetlands and their associated species have been rapidly declining during the past decades (Millennium Ecosystem Assessment, 2005; Davidson, 2014). In developing countries, like Ethiopia, wetlands and their biodiversity are prone to loss due to human disturbance and economic activities such as agriculture, house construction, disposal of domestic sewage and farming (Mereta et al., 2013).

Macroinvertebrates and birds are often used for biomonitoring as they respond to environmental change. Macroinvertebrates respond to changes in nutrients, energy flow, habitat structure and oxygen availability (Covich et al., 1999; Steinman et al., 2003; Saloom and Duncan, 2005). Similarly, wetland birds are also considered as bio-indicators as they are widely distributed, can be easily sampled, are sensitive to environmental change and their taxonomy is well-known (O'Connell et al., 2000; Gregory et al., 2003; Alleva et al., 2006; Naccari et al., 2009; Herrando et al., 2014).

Despite the ecological importance and management concern, research on macroinvertebrates and wetland birds is given little attention in protected areas and biosphere reserves in developing countries (Zamora-Marín et al., 2016). As a result there is no or little information

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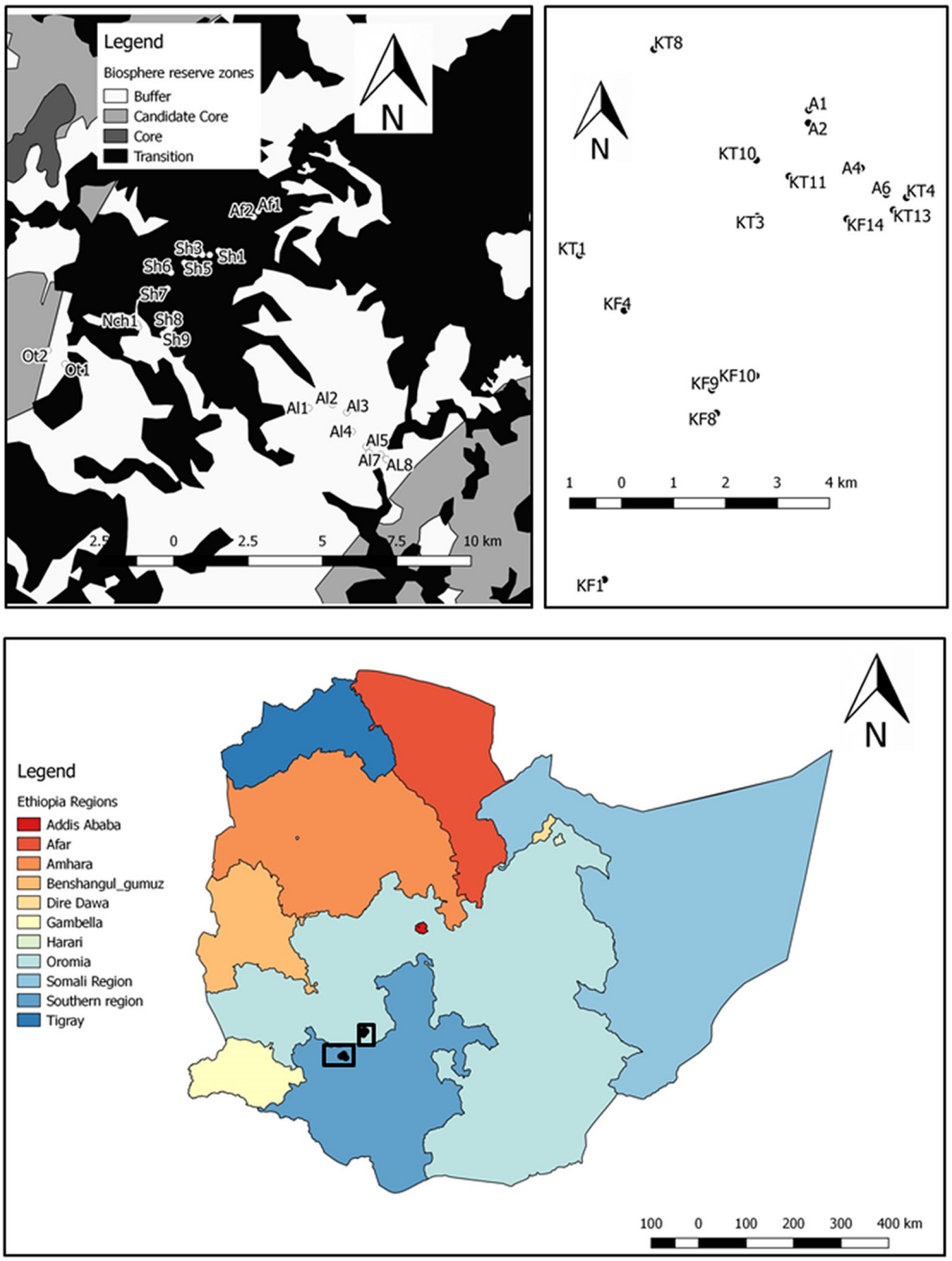

Fig. 1. Overview of the study are in Ethiopia and detailed location of the study area and wetland sampling stations.

on how important protected areas are for freshwater biodiversity (Herbert et al., 2010; Zamora-Marín et al., 2016). Although a few protected areas have been established in developing countries to conserve freshwater biodiversity, they are affected by land-use disturbances, altered hydrology, and introduction of non-native species (Saunders et al., 2002). Kafa biosphere reserve, situated in the Horn of Africa, is an example of such a worldwide biodiversity hotspot and is globally considered important for species conservation (NABU, 2014). It has been designated as a biosphere reserve since 2010 to conserve endemic and global important genetic resources of *Coffee arabica* and its associated ecosystems (UNESCO, 2010). Although wetlands are widely distributed in this biosphere reserve, little is known about the water quality and the diversity of macroinvertebrates and wetland birds in this ecosystem.

Conservation practitioners often use biological diversity as the main criterion to identify and prioritize ecosystems with a high conservation interest. However, biological diversity can be divided in alpha, beta and gamma diversity (Whittaker, 1960). Alpha diversity is the diversity of species within sites and can be measured as species richness. Alpha diversity can provide information on the effects of anthropogenic stressors on local habitat assemblages, but does not provide information on among-site variation, which is an important component of gamma diversity (Maloney et al., 2017). Beta diversity is the extent of change in community composition among sites (Whittaker, 1960). Beta diversity can be further divided in to turnover and nestedness (Baselga, 2010). Turnover is the replacement of species due to biotic, environmental or historical restrictions, whereas nestedness occurs when the biota of sites with smaller numbers of species are subsets of the biota at richer sites (Baselga, 2010). Partitioning beta diversity is used to identify the contribution of its components, which is important to explain biodiversity patterns and to plan conservation strategies (Baselga, 2010; Calderón-Patrón et al., 2016). Moreover, measuring beta diversity helps