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ARTICLE

Abyssinian Blue-winged Goose *Cyanochen cyanoptera* Rüppell, 1845 population size, distribution, and habitat association in the central-south highlands of Ethiopia

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Abstract: The endemic and threatened Abyssinian Blue-winged Goose *Cyanochen cyanoptera* is restricted to the Ethiopian highlands, yet its population ecology and habitat use remain limited. This study assessed population size, spatial and temporal distribution, and habitat utilization across wetlands in the central-south highlands of Ethiopia over three consecutive years (2015–2018). Population counts were conducted using the total count method, and data were analysed in Jamovi (v2.5.6) and R (v4.5.1). Mean population counts varied significantly across months, with peak abundance in August (3,136 ± 105 individuals) and the lowest in May (420 ± 24 individuals). Generalized linear mixed models indicated that habitat type and season significantly influenced abundance, while random effects of sites (ICC = 0.682) and month (ICC = 0.141) accounted for substantial unexplained variation. Model-adjusted estimates showed significantly lower abundance in farmland habitats (39.9 geese, 95% CI: 19.3, 82.1) compared with shoreline (63.4 geese, 95% CI: 30.7, 131, ratio = 0.63, z = -5.37, p < 0.001) and grassland (69.8 geese, 95% CI: 33.9, 143.7, ratio = 0.57, z = -6.95, p < 0.001), with no significant difference between the latter two (ratio = 0.91, z = -1.09, p = 0.52). Habitat use showed strong seasonal variation (p < 0.001), with increased reliance on farmland during the dry season and preference for shoreline and grassland habitats during the wet season, reflecting seasonal plasticity. Although the overall population appears to be stable, its distribution is highly dynamic and driven by resource availability and specific habitat preferences. Increasing conversion of wetlands and communal grazing lands into agricultural fields has reduced core habitats, altering traditional land-use systems and intensifying human–geese interactions. These findings underscore the importance of wetland size, habitat quality, and socio-ecological drivers in shaping the distribution of *C. cyanoptera.* The long-term persistence of this range-restricted species will depend on protecting key wetlands and promoting sustainable land-use practices that balance conservation with local livelihoods.

Keywords: Agricultural expansion, endemic species, generalized linear mixed models, habitat selection, population status, seasonal distribution.

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Author contributions: Solomon Mengistu: Conceptualization, Methodology, Formal analysis, investigation, Data Curation, Writing-Orginal Draft, Writing - Review & Editing, Visualization. Afework Bekele: Conceptualization, Methodology, Validation, Resource, Writing-review & Editing, Supervision, project administration, Funding Acquisition.

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INTRODUCTION

Ethiopia comprises nearly 70% of the afro-tropical landmass above 2,000 m elevation, with intensive areas exceeding 3,000 m (Yalden 1983). These highlands, bisected by the Great Rift Valley, host isolated mountain systems rich in endemic flora and fauna (Hillman 1993; Tedla 1995; Dixon et al. 2021). Owing to its topographic diversity, Ethiopia forms part of two global biodiversity hotspots–the Eastern Afromontane and the Horn of Africa–supporting unique high-altitude ecosystems and specialized wildlife (Ebi 2014). Altitudinal gradients strongly influence species distributions, particularly among waterfowl adapted to alpine wetlands and grasslands.

Ethiopia comprises over 880 bird species, including several endemic and range-restricted taxa (Ash & Atkins 2009; Desalegn 2023). The Abyssinian Blue-winged Goose *Cyanochen cyanoptera*, Rüppell 1845, is Ethiopia's only endemic goose and is restricted to highland ecosystems ranging 1,800–4,500 m (Urban & Brown 1971; Ash & Atkins 2009; McCracken et al. 2009). The species occupies Afro-alpine grasslands, marshes, streams, and freshwater wetlands, where it primarily feeds on short grasses and sedges (Brown et al. 1982; Scott & Rose 1996). Although historically described as locally common in parts of the Ethiopian highlands (Urban & Brown 1971; Brown et al. 1982). Its distribution remains closely associated with high-altitude wetlands and adjacent grasslands.

Wetlands globally have experienced rapid decline due to land-use change, agricultural expansion, and urbanization (Mammides 2020; Cao et al. 2023; Fluet-Chouinard et al. 2023), leading to steeper population declines in wetland species compared to their terrestrial counterparts (Cao et al. 2023). Similar pressures affect Ethiopian wetlands, many of which occur within Important Bird and Biodiversity Areas (IBAs) and are increasingly degraded by cultivation, livestock grazing, and settlement expansion (Williams et al. 2004). Habitat loss and fragmentation reduce the availability of suitable breeding and feeding sites, posing significant threats to wetland-dependent species (Byju et al. 2025a). In the Ethiopian highlands, continued conversion of wetlands to farmland and expansion of eucalyptus plantations have further intensified habitat degradation.

Species with restricted distribution, such as *C. cyanoptera*, are particularly vulnerable to habitat changes because their survival depends on limited and specialized environments. Increasing human population pressure and agricultural expansion have altered many of these landscapes, and current information on population size, distribution patterns, and habitat associations remains limited. Despite its ecological significance and restricted range, *C. cyanoptera* remains poorly studied compared to other African waterfowl. Reliable and updated data on its population status and habitat use are essential for conservation planning, particularly in regions experiencing rapid environmental changes. Therefore, the present study aimed to determine the population size, distribution, and habitat use of *C. cyanoptera* in the central-south highlands of Ethiopia. The study also identifies key congregation sites and provides baseline ecological information to support effective conservation planning and management of this endemic species.

MATERIALS AND METHODS

Study Area

The study was conducted in the central-south highlands of Ethiopia within the Gurage Zone of the central Ethiopia region (7.667°–8.500° N, 37.500°–38.667° E) (Image 1). Its elevations range 1,000–3,719 m, with Mount Zebidar (Gurage Mountain) forming the highest peak. It lies along the western margin of the Great Rift Valley and forms part of an important watershed draining into the Awash, Rift Valley, Bilate and Omo-Gibe basins (Sahle et al. 2019). Gurage Zone is among the most densely populated areas in Ethiopia, with population densities exceeding 450 persons per km² (Sahle & Yeshitela 2018), resulting in increasing pressure on natural habitats.

Site Selection

Field surveys were conducted at two major wetland systems: Bojuabar wetlands in Ezha Woreda and Arekit Valley wetlands in Gumar Woreda (Image 1). Bojuabar wetlands consist of three small highland lakes–Bojuabar, Bojuabar-Akilil, and Elas-Eyesus, located along the Zebidar Mountain chain. These wetlands, associated with open grasslands, are under pressure from the expansion of agricultural lands and eucalyptus plantations, but remain important feeding, breeding, roosting, and molting habitats of *C. cyanoptera*.

Bojuabar Lake is located 200 km southwest of Addis Ababa and 28 km from Butajira, with coordinates of 8.050–8.267°N latitude and 37.833–38.200°E longitude. It is a larger lake with a surface area of 9.8 ha, located about 1 km south of Bojuabar town. The larger part (75%) is covered by Eucalyptus *Eucalyptus globulus* forest, yet

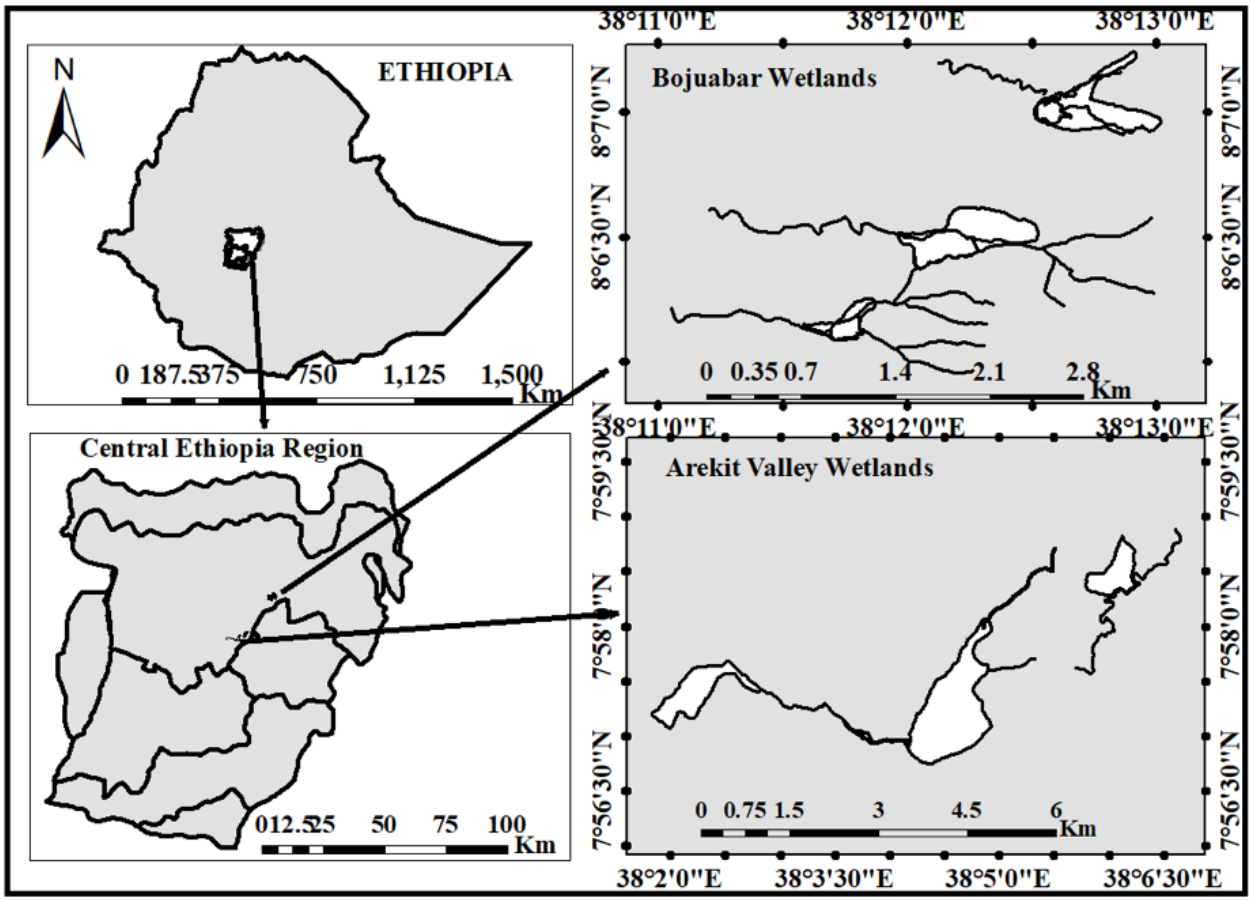

Image 1. The study area.

it remains a critical feeding, roosting, and molting habitat of Abyssinian Blue-winged Geese and a small population of Egyptian Geese *Alopochen aegyptiaca*. The area is also a wintering habitat for Palearctic birds.

Bojuabar-Akilil Lake is a small lake adjacent to Bojuabar town on the northern side. This lake is also used by Abyssinian Blue-winged Geese for feeding, roosting, breeding, and molting. It has a surface area of about 3.4 ha.

Elas-Eyesus Lake is the smallest lake situated about 0.5 km south of Bojuabar Lake. It is used as a breeding site for Abyssinian Blue-winged Geese and a pair of Egyptian Geese. It has a surface area of about 2.8 ha.

Weira River originates from the Zebidar Mountain range and flows west through the southern edge of Gumer Woreda, joining the Bilate River, which flows southwards to Lake Abaya. It possesses scattered forest dominated by Eucalyptus trees and patchy open grassland along its course. Most of the flat grasslands have been converted to farmland, leaving only swampy and hilly areas. Weira River is also an important breeding habitat for birds, particularly during the short rainy season.

Arekit Valley Wetlands consist of Arekit Lake and Zizencho Wetland. Lake Arekit is a shallow (2.5–3.2 m depth), rain-fed freshwater lake located at an elevation of 2,820–2,950 m, with a surface area of about 136 ha (Yirga et al. 2023). It is situated along the Addis Ababa-Wolkite-Hosanna road, about 55 km north of Hosanna and 228 km from Addis Ababa, with coordinates of 7.9500°–7.9667° N and 38.0750°–38.0833° E (Yirga et al. 2023). The lake has relatively important phytoplankton diversity (i.e., 34 taxa) and 56 bird species (Belete et al. 2022; Enawgaw & Wagaw 2023). It is a critical habitat for the *C. cyanoptera* as breeding, feeding, roosting, and molting habitats. Arekit Lake is under threat from the expansion and intensification of agriculture and urbanization. The Zizencho wetland is located 4 km north of lake Arekit along its outlet. It has small swampy grasslands associated with three temporary ponds at the eastern and western parts of Zizencho town. It is used as a feeding and breeding habitat for a small population of *C. cyanoptera*. This wetland is also threatened by agricultural expansion and settlement development.

Climate

The study area experiences marked climatic variation influenced by elevation, with a gradient ranging 1,000–3,638 m (Zerga et al. 2023). The mean annual rainfall and temperature were 916 mm and 16.6 °C at Arekit, and 1,153 mm and 17.3 °C at Bojuabar, respectively (Nmsa 2019).

Study design and population data

Population surveys of the *C. cyanoptera* were conducted over 36 months from November 2015 to October 2018. Surveys were repeated annually following similar seasonal time periods. The year was divided into three ecologically relevant seasons: dry season (November–February), short rainy season (March–May), and wet season (June–October), based on the amount of rainfall, vegetation phenology, and the distribution pattern of the species. Dry season is characterized by low humidity, diminished vegetation growth, and receding water level. The dry season spans two calendar years and is expressed using a split-year format (e.g., 2015/16).

The short rainy season is marked by intermittent rainfall and emergent vegetation growth, which triggers the breeding season of *C. cyanoptera.* The wet season is characterized by heavy and continuous rain with abundant vegetation growth and resources. This season is known for the congregation of *C. cyanoptera* for molting in large Lakes associated with grazing lands.

Habitats within each study site were classified into three major categories based on landscape features and observed habitat use: open water and shoreline, grassland, and farmland. Open water and Shoreline habitats (for simplicity, Shoreline habitats) included open water with emergent vegetation and adjacent zones within 10–25 m from lake margins, which provide critical feeding, nesting, roosting, escaping refuge sites, and resting areas for *C. cyanoptera*.

Grassland habitats consisted of open areas with natural or semi-natural grazing lands dominated by short grasses. These habitats have progressively declined due to conversion to farmland and urbanization activities. Farmland habitats included fallow, ploughed, and actively cultivated fields frequently utilized by *C. cyanoptera.*

The population size of the *C. cyanoptera* was estimated using the total count method from 51 fixed vantage points systematically selected to provide maximum visibility across wetlands and surrounding habitats. These observation points were established based on landscape features and vegetation cover, with distances of 300–500 m between consecutive points depending on habitat visibility. Surveys were conducted during peak activity periods (0600–1000 h and 1400–1800 h) using 10 x 42 binoculars. Individual birds in small flocks were counted directly, while larger flocks were estimated in groups of 10 or 100 individuals to maintain accuracy and efficiency. Each site was surveyed twice daily for three consecutive days each month by a team consisting of the researcher and two trained assistants. Daily mean counts were calculated for each habitat type.

Data Analyses

The population count data were organized in Excel by year, month, season, site, and habitat type. Data were exported as comma-separated values (CSV) files for analysis. Statistical analyses were conducted using Jamovi v2.3.28 and R v4.5.1. Descriptive statistics were used to summarize temporal and spatial variation in population counts across sites, seasons, and habitat types. Data normality was assessed using a Shapiro-Wilk or Kolmogorov-Smirnov test. Pairwise comparisons were conducted using the Type II Wald test, followed by Tukey's HSD post-hoc test for significant effects. Generalized linear mixed models (GLMMs) were employed to examine variation in population counts across sites, habitats, seasons, years, and months. Count data were analyzed using Negative Binomial error distribution to account for overdispersion and zero-inflation (Bolker et al. 2009). Random effects were included to account for temporal and spatial variation, with site and month treated as random factors. Models were fitted using the glmmTMB package in R. Model diagnostics were performed using DHARMa package to evaluate residual patterns and model fit. Statistical significance was tested using Type II Wald chi-square tests, and post-hoc comparisons were conducted using estimated marginal means (EMMs) with Tukey adjustment.

RESULTS

Population Size of Abyssinian Blue-winged Goose

The study revealed that the population size of *C. cyanoptera* varied across survey months and years. The highest mean population counts (Mean ± SD) were recorded in August 2018 (3,215 ± 61.27 individuals), followed by August 2017 (3,049 ± 54.31 individuals) (Image 2). The lowest count was recorded in May 2016 (251 ± 20.22 individuals). The overall monthly population trends, irrespective of year and site, showed the highest mean population size (Mean ± SD) in August (3,136.17

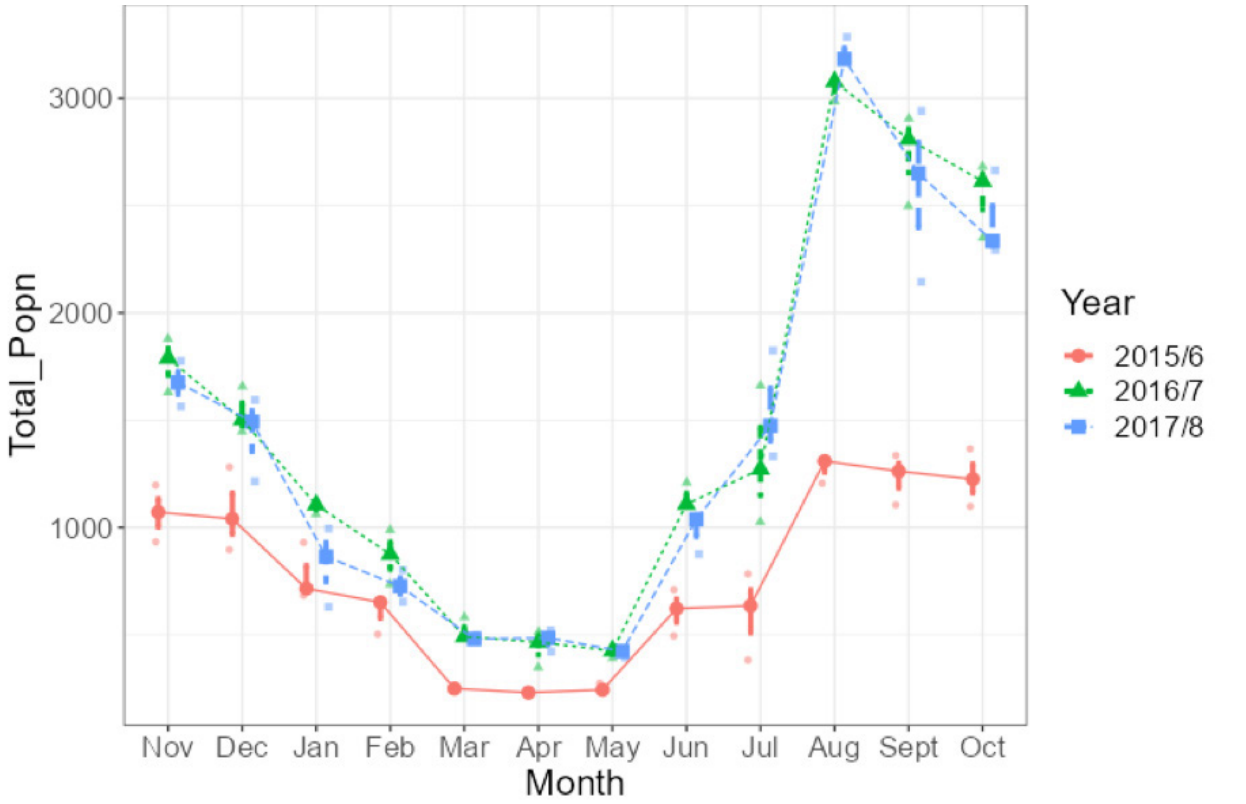

Image 2. The overall mean total population counts across the months and years in the central-south highlands of Ethiopia from 2015–2018.

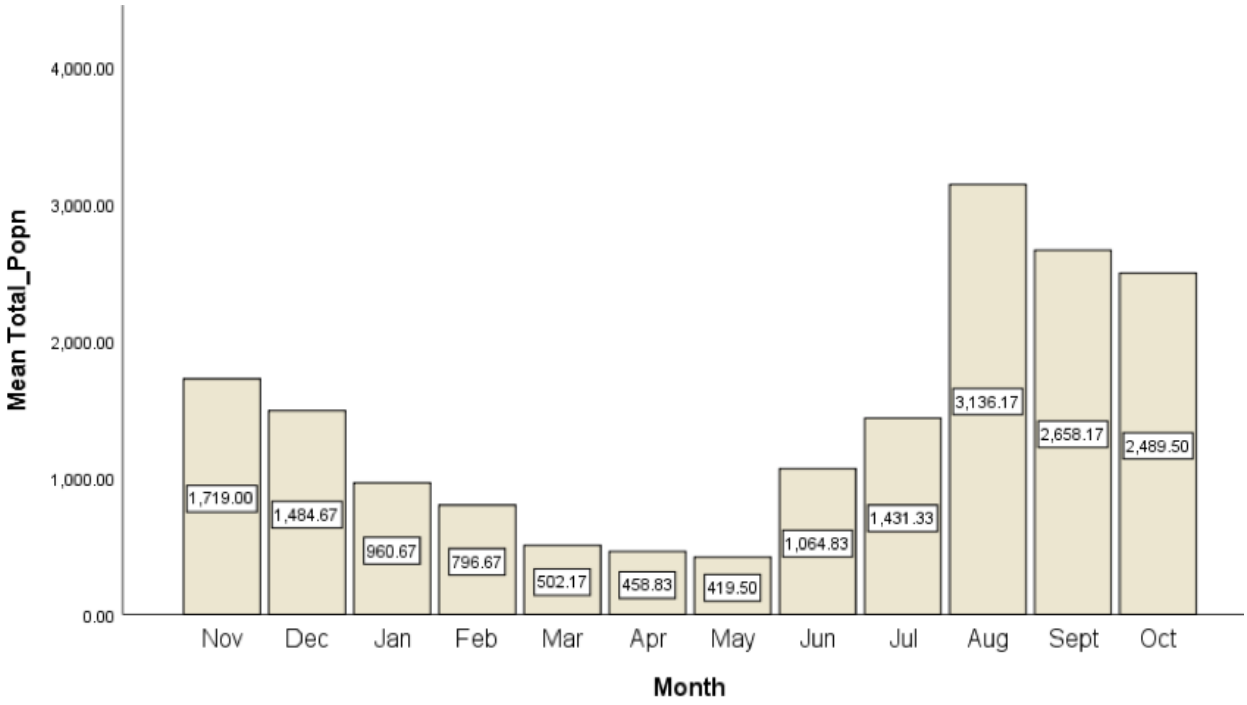

Image 3. The overall mean total population counts across the months in the central-south highlands of Ethiopia from 2015–2018.

± 104.50 individuals) and the lowest in May (419.50 ± 23.65 individuals) (Image 3). Population counts gradually declined from August to May and increased from June to August.

A GLMM with negative binomial distribution was fitted to assess the effect of year, habitat, and season on abundance, with random intercepts included for site and month. The GLMM revealed that the overall effect of year on abundance was insignificant (Type II Wald χ^2 = 1.52, df = 2, p = 0.467). Compared to the baseline year (2015/2016), the yearly coefficients were not statistically significant (2016/2017: β = -0.128, p = 0.236; 2017/2018: β = -0.124, p = 0.253). Mean population counts across the habitats, seasons, and years were the highest in farmland during the dry season, whereas during the wet season, both shoreline and grassland habitats supported the highest mean population counts across the study years (Image 4).

The GLMM indicated significant effects of habitat (Type II Wald χ^2 = 55.06, df = 2, p < 0.001) and seasonal effect (Type II Wald χ^2 = 19.54, df = 2, p < 0.001) on spatial and temporal distribution and abundance of the *C. cyanoptera*. Model-adjusted estimated marginal means (EMMs) of abundance were the highest in the grassland (69.8 geese, 95% CI: 33.9–143.7) and shoreline habitats (63.4 geese, 95% CI: 30.7–131) and the lowest in farmland habitat (39.9 geese, 95% CI: 19.3–82.1). Post-hoc Tukey tests showed that abundance in farmland habitats was significantly lower than in both shoreline (ratio = 0.63, z = -5.37, p < 0.001) and grassland habitats (ratio = 0.57, z = -6.95, p < 0.001). But there was no significant difference in abundance between shoreline and grassland habitats (ratio = 0.91, z = -1.09, p = 0.52).

Model-adjusted estimated marginal means (EMMs) indicated that abundance during short-rainy season (33.9 geese, 95% CI: 15.9–72.4) was significantly lower than during both the wet season (76.3 geese, 95% CI: 36.3–160.5; ratio = 0.45, p < 0.001) and dry season (68.1 geese, 95% CI: 32.4–143.2; ratio = 0.50, p < 0.001). No significant difference in abundance was detected between the dry and wet seasons (ratio = 0.89, p = 0.799).

GLMM indicated that the random effect of site (ICC = 0.682) and month (ICC = 0.141) accounted for 68.2% and 14.1% of the variance, respectively. A Welch's ANOVA confirmed significant variation in abundance across sites ($F_{Welch(4,186.4)}$ = 94.49, p < 0.001); with large effect size ($\dot{\eta}^2_p$ = 0.67; 95% CI: 0.61–1.00) (Image 5). Post-hoc Pairwise Comparisons using the Adjusted-Game Howell test indicated significant differences (p < 0.001) between most sites, except between Arekit Lake and Bojuabar Lake ($P_{(Holm-adj)}$ = 0.12), and between Zizencho wetland and Elas-Eyesus Lake ($P_{(Holm-adj.)}$ = 0.21) (Image 5).

Welch's ANOVA test also confirmed significant variation in abundance across seasons ($F_{Welch(2, 193.3)}$ = 53.00, p < 0.001, $\dot{\eta}^2_p$ = 0.35; 95% CI: 0.26–1.00) (Image 6). The wet season had 1.4× marginally higher abundance than the dry season (p = 0.02) and 3.7× significantly higher abundance than the short-rainy season (p < 0.001). The dry season likewise had 2.64x significantly higher abundance than the short-rainy season (p < 0.001) (Image 6). The relative use of different habitat types was assessed based on the number of individuals recorded in each habitat (Image 7). Habitat use varied significantly across seasons (t = -12.5, df = 966, p < 0.000). During the dry season, farmland (38.30%) and shoreline (36%) habitats were preferred by the highest proportions of individuals, with the least records in grassland habitats (26%). During the short-rainy season, grassland (43.00%) and Shoreline (31.51%) habitats were preferentially utilized by *C. cyanoptera*, while farmland habitats (25.46%) were the least utilized. During the wet season, shoreline (51.36%) and grasslands (35.83%) habitats were preferred by the highest proportions of the individuals, while only 12.82% of the *C. cyanoptera* individuals utilized farmland habitats (Image 7).

The habitat utilization varied significantly across the months (p < 0.000). Utilization of shoreline habitat reached its peak in August (61.51%) and declined to its lowest level in May (31.49%) (Image 8). Grassland habitat utilization was highest in May (46.25%), following the light rainfall in February, and lowest in December (22.79%). Farmland habitat utilization was lowest in August (9.00%) and increased progressively to reach its peak in December (42.25%) (Image 8). Habitat utilization varied significantly across study sites (p < 0.000). Shoreline habitats were utilized the most at Bojuabar Lake (45.60%), followed by Arekit Lake (39.48) and the lowest at Bojuabar-Akilil Lake (Image 9). In contrast, farmland habitat utilization was highest at Elas-Eyesus Lake (29.61%), followed by Arekit Lake (27.77%) and Bojuabar-Akilil Lake (23.22%) and the lowest at Bojuabar Lake (17.72%). At Zizencho wetland, grassland habitat accounted for 81% of habitat use, while farmland accounted for 19.00%. The highest grassland utilization was recorded at Zizencho wetland (81%), followed by Bojuabar-Akilil Lake (44.26%) and the lowest at Arekit Lake (32.75%) (Image 9).

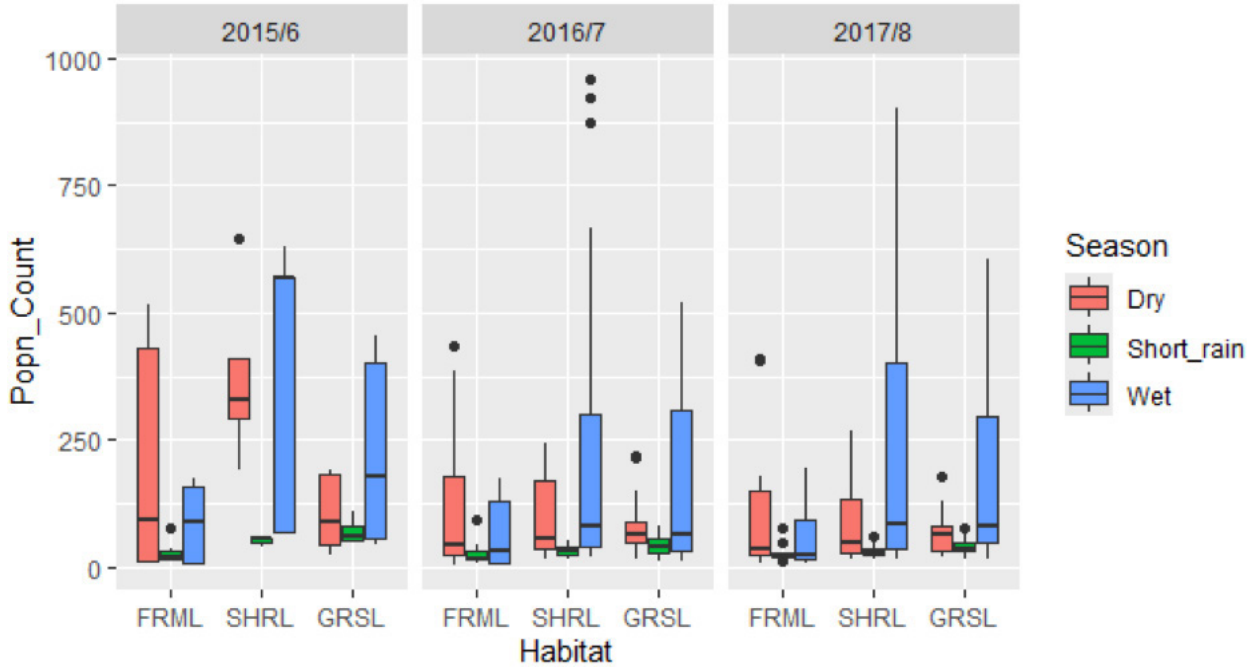

Image 4. The mean population counts across habitat, season, and year in the central-south highlands of Ethiopia from 2015–2018.

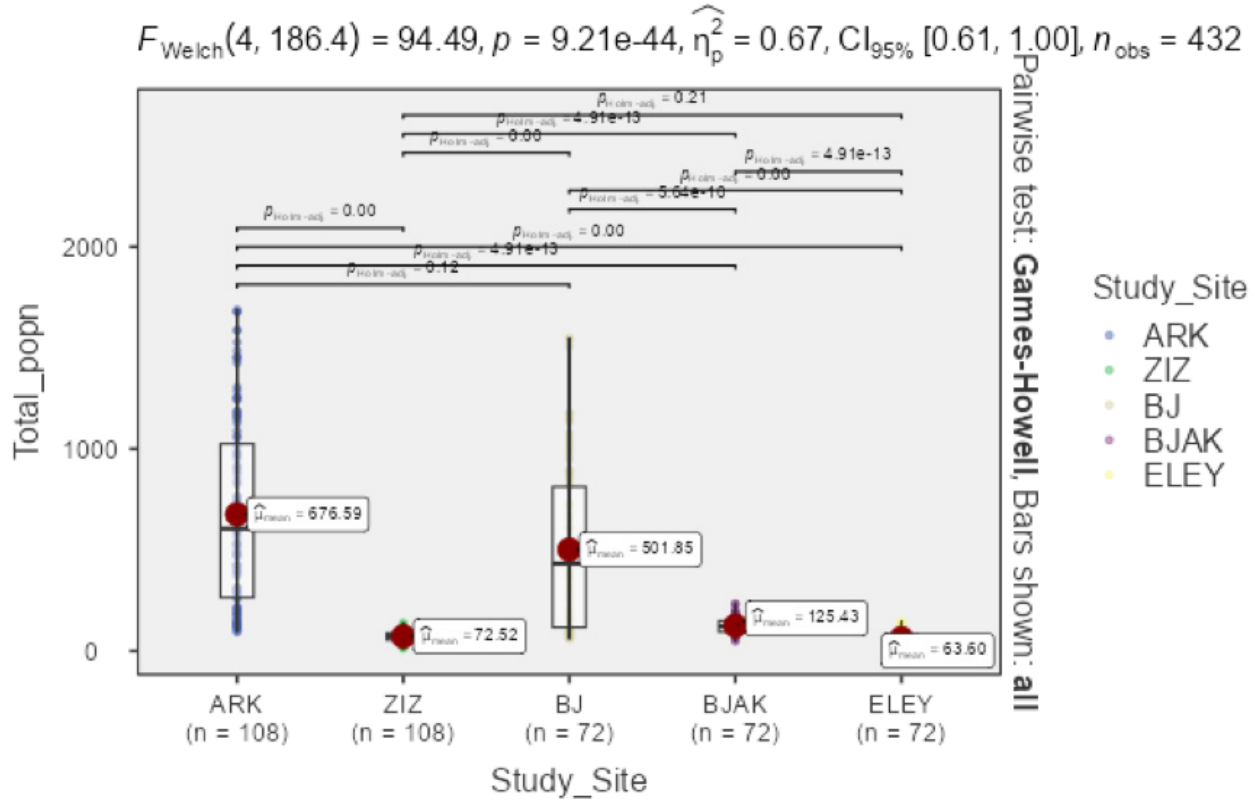

Image 5. Post-hoc pairwise comparison (Adjusted Game Howell test) between sites in the central-south highlands of Ethiopia from 2015–2018.

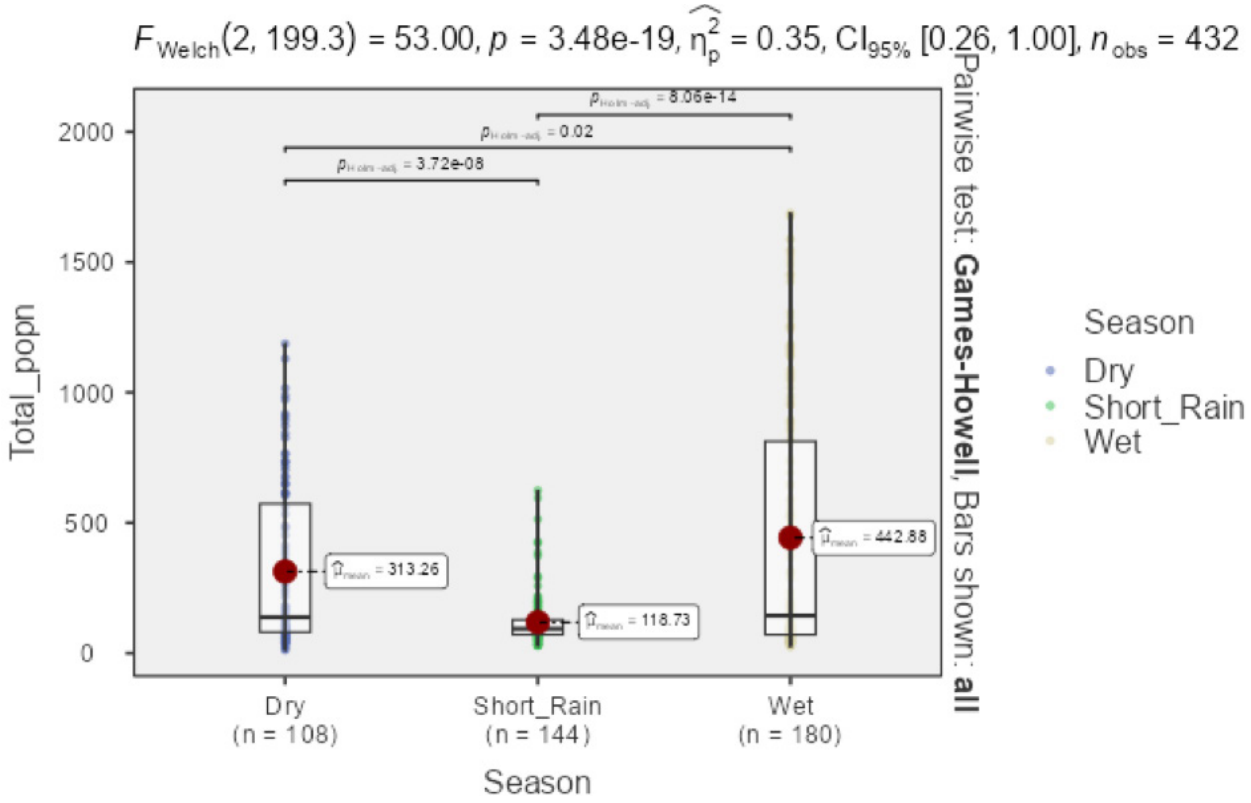

Image 6. Post-hoc pairwise comparison (Adjusted Game Howell test) between seasons in the central-south highlands of Ethiopia from 2015–2018.

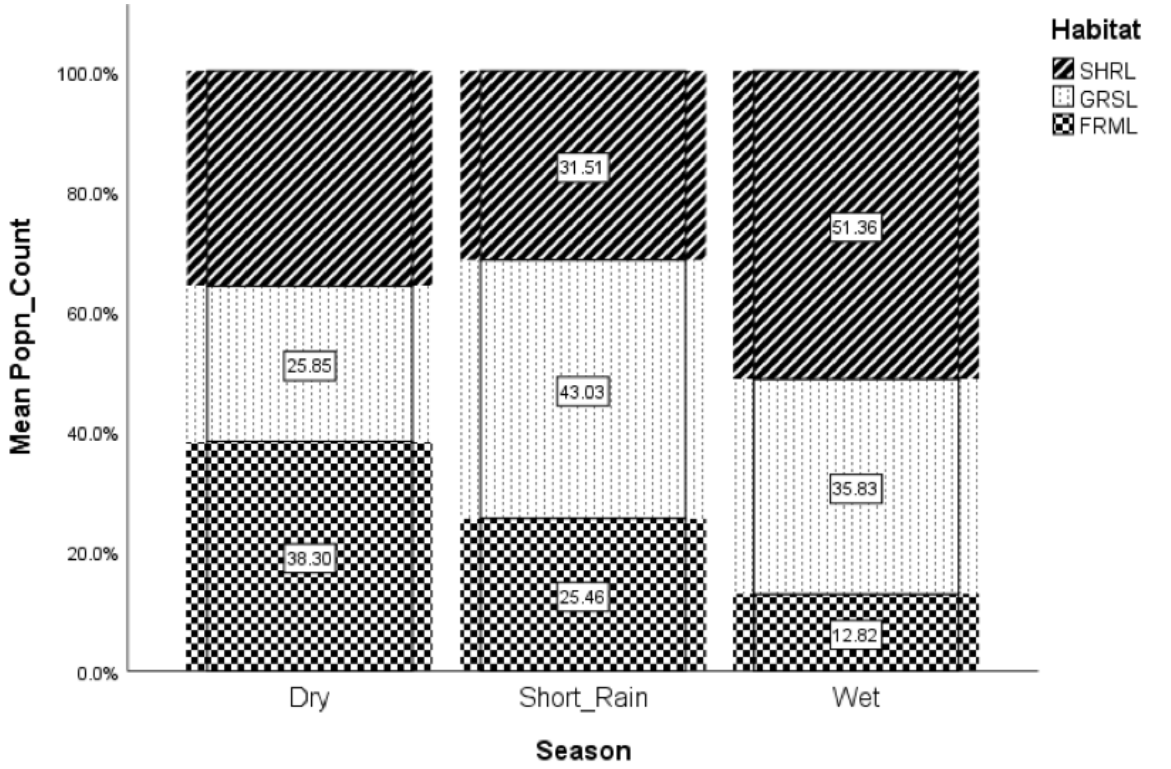

Image 7. Percentage of habitat utilization by *Cyanochen cyanoptera* in the central-south highlands of Ethiopia across the three habitat types from 2015–2018.

DISCUSSION

The present study identified for the first time Arekit Lake and Bojuabar Lake in the central-south highlands of Ethiopia as critically important habitats for the threatened Abyssinian Blue-winged Goose. These two lakes supported higher population sizes than other surveyed sites, particularly during the long rainy season (June–August), with peak abundance recorded in August. This period coincided with increased availability of natural food resources, including grasses and herbaceous vegetation.

The large and permanent open-water areas of Arekit and Bojuabar lakes likely provide refuge from predators and anthropogenic threats, particularly during the flightless molting periods. Wetlands that support large congregations during molting are considered essential habitats for waterfowl conservation. The annual molting congregations recorded at Arekit and Bojuabar lakes represented more than 20% of the global population estimates of *C. cyanoptera* (5,000–15,000 individuals) reported by previous studies (Brown et al. 1982; Callaghan & Green 1993; Scott & Rose 1996), highlighting the conservation significance of these wetlands and their suitability as IBAs. In contrast, smaller wetlands such as Bojuabar_Akilil Lake, Elas-Eyesus Lake, and the temporary ponds within Zizencho wetland supported comparatively lower population sizes, likely due to their limited open-water extent and reduced refuge opportunities during molting.

Seasonal variation in abundance and habitat utilization was likely influenced by changes in forage availability, molting requirements, and breeding dispersal. Population counts of the *C. cyanoptera* declined from September to May following the molting period, which may be related to seasonal changes in vegetation quality, as forage palatability typically decreases with plant maturation (Van Der Wal et al. 2000). Similar post-molting habitat shifts have been reported in other goose species (Madsen & Mortensen 1987). During the dry season, *C. cyanoptera* increasingly utilized farmland habitats, particularly post-harvest fields containing cereal seeds, weeds, and crop residues that provide alternative food resources when natural forage becomes less nutritious. The increased use of agricultural habitats during the period of declining forage quality is

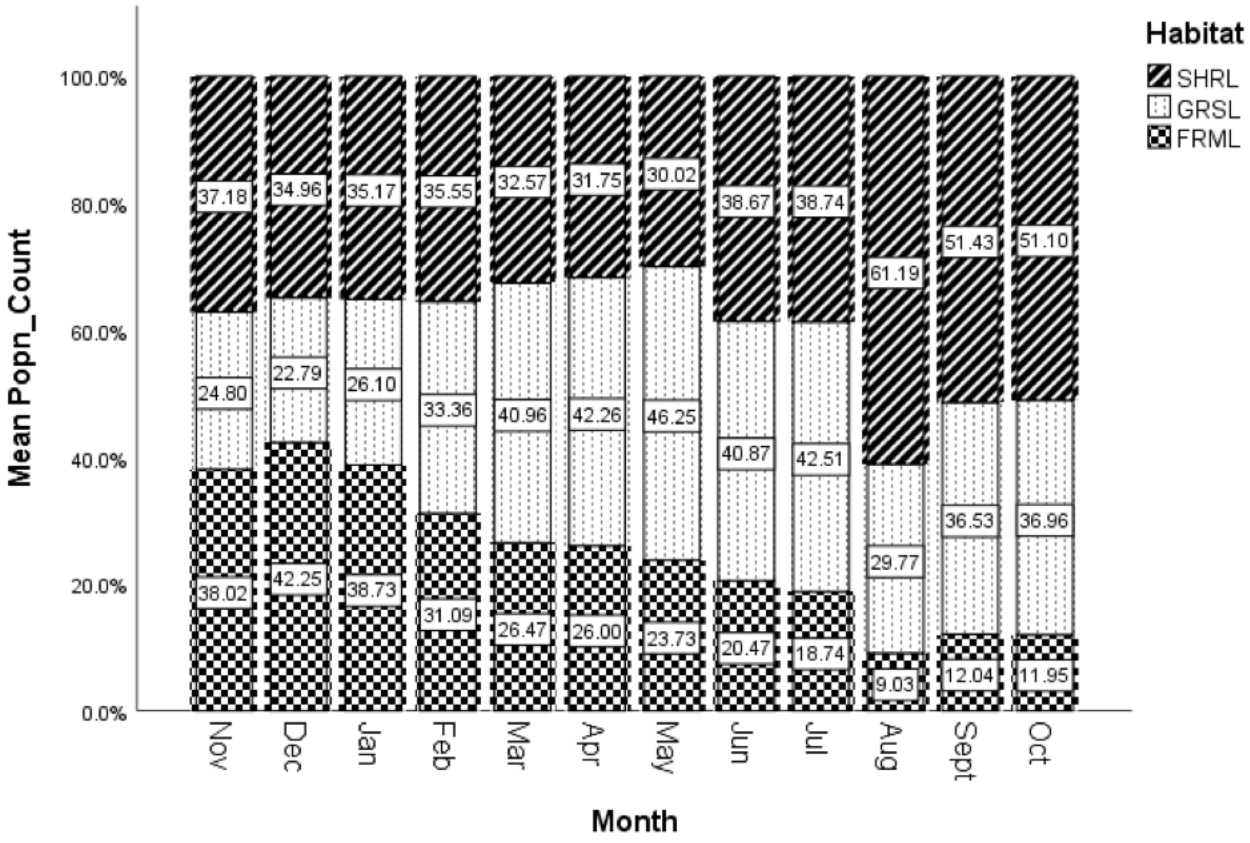

Image 8. Percentage of habitat utilization by *Cyanochen cyanoptera* in the central-south highlands of Ethiopia across the months from 2015–2018.

consistent with observations reported for Canada Geese *Branta canadensis*, Greylag Geese *Anser anser*, Greater White-fronted Geese *Anser albifrons*, and Egyptian Goose *Alopochen aegyptiaca* (Mangnall & Crowe 2002; Ely & Raveling 2011; Askren 2021; Zhang et al. 2023).

The significantly lower abundance recorded during the short-rainy season was likely associated with breeding dispersal. Unlike colonial breeding waterfowl, *C. cyanoptera* breed in dispersed pairs and are scattered across streams, riverbanks, seasonal wetlands, and other breeding habitats during this period. Light rainfall occurring toward the end of February triggered the re-growth of perennial grasses and germination of cereal residues and weeds, creating more spatially dispersed feeding opportunities. Consequently, birds became less concentrated around wetlands. Similar patterns of breeding dispersal linked to food availability were reported for Egyptian Goose in South Africa (Mangnall & Crowe 2002).

Habitat utilization patterns demonstrated clear seasonal shifts, with the highest densities recorded in core areas of optimal habitat (Gerhardy et al. 2025). Shoreline and grassland habitats supported the highest abundance of *C. cyanoptera* during the wet season, whereas farmland habitats became increasingly important during the dry season. The comparable abundance recorded between shoreline and grassland habitats suggests that both habitats appeared to provide feeding and refuge opportunities for *C. cyanoptera*. A marked decline in grassland areas was observed due to conversion to agricultural land. At Arekit Lake, communal grazing lands have been converted to farmlands and urban settlements, resulting in a reduction of core habitats used by *C. cyanoptera*. Agricultural expansion and urbanization therefore, represent major anthropogenic threats contributing to habitat loss in the central-south highlands of Ethiopia. During the wet season and molting period, birds remained closely associated with shoreline habitats near permanent open-water where graminoids and herbaceous vegetation were abundant, and disturbance was relatively low. Geese typically prefer habitats with abundant food resources and access to water for predator avoidance (Hughes et al. 1994). Habitat selection is also influenced by behavioral factors such as flocking benefits and individual fitness (Aplin et al. 2014).

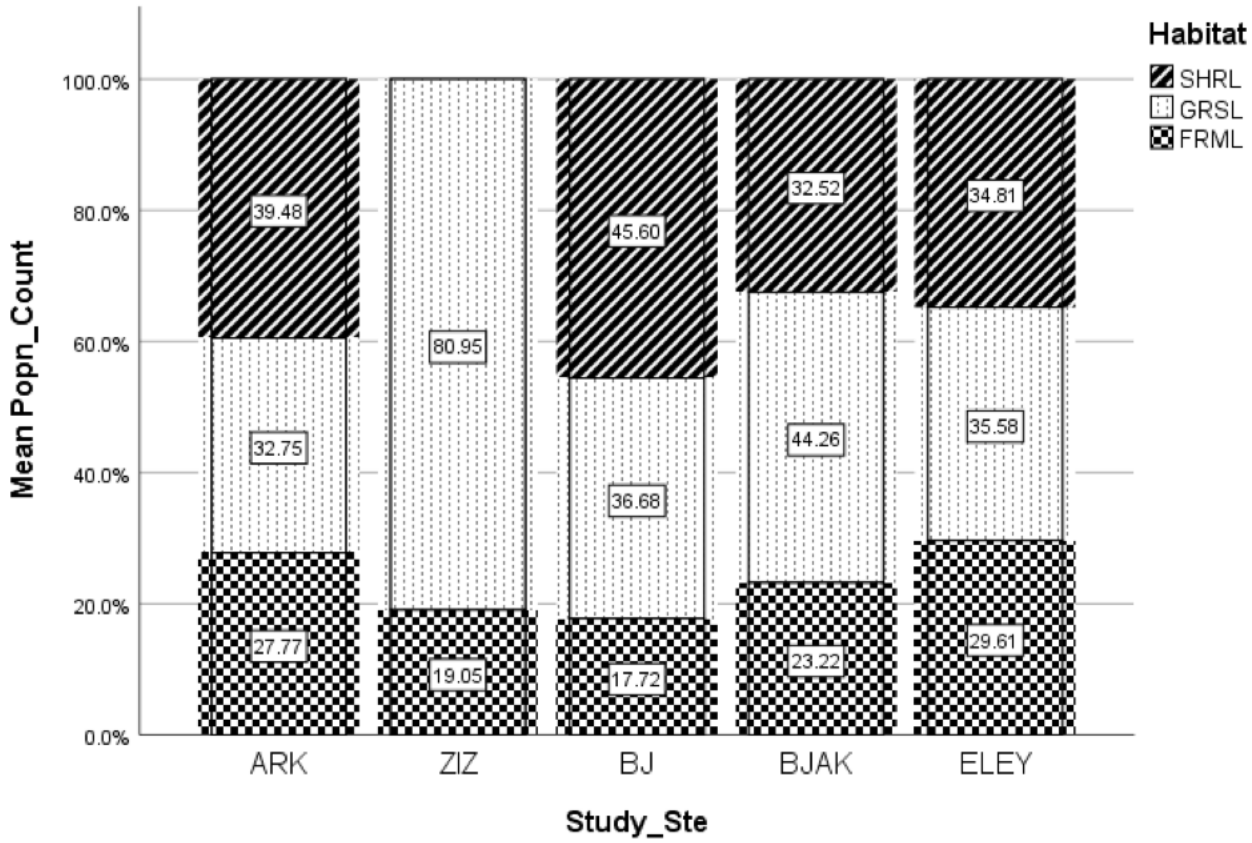

Image 9. Percent of habitat utilization of the bird in the central-south highlands of Ethiopia across the study site from 2015–2018.

Shoreline habitat utilization peaked during August when birds were concentrated around permanent wetlands during molting. Grassland habitat utilization increased toward May following light rainfall and regeneration of fresh vegetation. These findings indicate that habitat use by *C. cyanoptera* changed seasonally in response to resource availability. Most geese are grazing herbivores that specialized in short, high-quality grass swards characterized by low fibre content and high digestibility (Fox et al. 2017). Similarly, *C. cyanoptera* primarily foraged on grasses and herbs in grassland and shoreline habitats during the wet season but shifted seasonally to farmlands and fallow fields during the dry season as natural forage quality declined. Increased utilization of agricultural habitats during periods of reduced natural forage availability has also been reported in other goose species (Fox & Abraham 2017).

The spatial variation in habitat use among study sites further reflected differences in habitat structure and wetland characteristics. Shoreline habitats were most intensively utilized at Bojuabar and Arekit lakes, which contain relatively larger permanent open-water areas and extensive shoreline vegetation. In contrast, grassland habitats dominated habitat use at Zizencho wetland, where temporary ponds and surrounding grasslands formed the principal habitat matrix. Farmland utilization was relatively higher at Elas-Eyesus Lake and Arekit, possibly reflecting greater agricultural encroachment and proximity of cultivated fields to wetlands. The high variance explained by site-level random effects in the GLMM supports the importance of local habitat conditions in determining abundance and habitat selection. Agricultural expansion into wetland margins and socio-economic pressures represent major anthropogenic threats contributing to habitat loss and degradation of wetlands in the central-south highlands of Ethiopia. Shoreline and grassland habitats around Arekit Lake have increasingly been converted into agricultural fields and human settlements, resulting in a reduction of important molting and feeding habitats used by *C. cyanoptera*. Similar but less extensive habitat conversion was also observed around Bojuabar Lake. Field observations and information obtained from local communities indicated that portions of communal grazing lands surrounding wetlands have recently been converted into agricultural lands managed by investors and organized youth groups, often with limited environmental safeguards (Belete et al. 2022). These land-use changes appear linked to broader development initiatives aimed at increasing agricultural productivity and employment opportunities. Such land-use changes have accelerated the loss of shoreline and grassland habitats that historically supported both wetland biodiversity and traditional community-based livelihood systems that developed for millennia. Traditionally, wetlands in the region functioned as communal grazing lands and sources of essential natural resources for local communities (Dixon et al. 2021). Indigenous land-use systems such as controlled grazing, seasonal land rotation, and fallowing historically contributed to the maintenance of wetland integrity while simultaneously supporting local livelihoods. Farmers in the central-south highlands of Ethiopia commonly leave farmland fallow for one or two years to restore soil fertility and support livestock grazing (Tolessa et al. 2016). Such fallow lands currently provide important alternative feeding habitats for *C. cyanoptera* after the molting season and may partially compensate for the loss of natural grassland habitats. However, continued conversion of shoreline and grassland habitats into agricultural fields has progressively reduced natural feeding grounds, increasing the species' dependence on cultivated lands and potentially increasing localized human-goose conflicts.

Historically, *C. cyanoptera* was not considered a major agricultural pest because farmlands were located away from molting wetlands such as Arekit and Bojuabar lakes. The species primarily utilized short-grazed grasslands around lakes and rarely used tall hay grasslands, except during nesting. This behavior may partly explain the relatively tolerant attitudes of local communities toward *C. cyanoptera* compared with other goose species such as A. *aegyptiaca* which nest on the top of traditional huts and are highly mobile and frequently forage in farmlands away from wetlands. Nevertheless, continued loss of natural habitats may increasingly force *C. cyanoptera* into cultivated areas, potentially intensifying future human-wildlife conflicts.

The interaction between local livelihood needs, agricultural development priorities, and ecological sustainability highlights the complex socio-ecological drivers underlying wetland degradation in Ethiopia. Similar wetland degradation associated with unregulated agricultural expansion has been reported elsewhere (Yu & Wu 2018; Desta et al. 2022; Byju et al. 2025b). Integrating indigenous resource-management practices such as controlled grazing and crop rotation into contemporary land-use planning may enhance long-term wetland sustainability while supporting conservation of important habitats for *C. cyanoptera*.

CONCLUSION

This study identified Arekit Lake and Bojuabar Lake as critically important molting, roosting, and feeding habitats for the threatened Abyssinian Blue-winged Goose in the central-south highlands of Ethiopia. Seasonal variation in abundance and habitat use was strongly associated with availability, molting requirement, and breeding dispersal. During the wet season, geese congregated in shoreline and grassland habitats around permanent lakes where food resources and refuge conditions were favorable. Following the molting period, birds dispersed into adjacent agricultural landscapes, utilizing fallow fields and crop residues during the dry season–a behavioral adaptation observed in other waterfowl species globally. The lower abundance observed during the short rainy season was associated with dispersal of breeding pairs to scattered breeding habitats and seasonal water bodies.

The study further demonstrated that local habitat characteristics strongly influenced abundance and habitat selection. Permanent wetlands with extensive open-water areas and shoreline vegetation supported larger molting congregations than smaller or temporary wetlands. Shoreline and grassland habitats functioned as complementary feeding and refuge areas, while farmlands provided important alternative feeding habitats during periods of reduced natural forage availability.

Agricultural expansion, urbanization, and conversion of communal grazing lands into cultivated fields were identified as major threats contributing to habitat degradation and loss of important molting and feeding habitats. Continued reduction of natural habitats may increase the dependence of *C. cyanoptera* on agricultural landscapes and intensify future human-wildlife conflicts. Protection of key wetlands such as Arekit and Bojuabar lakes, together with sustainable land-use planning that incorporates ecological safeguards and indigenous resource-management practices, is therefore essential for long-term conservation of the species. The long-term persistence of this range-restricted species will depend on protecting key wetlands such as Arekit Lake and Bojuabar Lake, together with promoting sustainable land-use practices that balance conservation with local livelihoods.

Future studies incorporating telemetry and broader landscape-level monitoring are recommended to improve understanding of movement patterns, breeding distribution, habitat connectivity, and seasonal dispersal of *C. cyanoptera*. Such information will be important for developing effective long-term conservation strategies for this range-restricted and threatened Ethiopian endemic goose species.

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