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STATUS OF ANTHROPOGENIC THREATS AND THREATENED SPECIES FOLLOWING RE-DEMARCATION OF THE AWASH NATIONAL PARK, ETHIOPIA

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ABSTRACT

One of the main conservation objectives of re-demarcating the Awash National Park (ANP) was to address its potential threats thereby ensuring its effective management and sound conservation of the threatened species. It was, however challenging to obtain up-to-date information on the status of severity of the anthropogenic threats and threatened species after re-demarcation of the park. The purpose of this study was to investigate the status of anthropogenic threats and threatened species following re-demarcation of ANP and the effectiveness of the conservation measures taken to address the potential anthropogenic threats to the protected area. Semi-structured questionnaires, key informant interviews and focus group discussions were used to collect data on anthropogenic threats. Sample and total count methods were deployed to determine distribution, density and abundance of the target species. Management effectiveness tracking tool (METT) assessment form was filled objectively by the assessors to compare the METT scores before and after re-demarcation of ANP. Analysis tests which include χ^2 test, t - test, Pearson correlation test and Wilcoxon test were deployed to determine the relationship and difference between various socio-economic and ecological variables. The result of this study reveals that eight out of the ten identified anthropogenic threats have been predominantly prevailing in ANP at varying degrees and the extent of majority of them had increased following re-demarcation. As a result, significant decline in distribution and abundance of the threatened species of mammals was witnessed. Generally, the major anthropogenic threats to the park have been persisting although the rationale for re-demarcating the ANP was to address these potential threats. It is therefore recommended to identify the main drivers for the core anthropogenic threats, devise adaptive management approaches for ANP and enable effective implementation of its conservation actions. It is also suggested to enhance land use planning in areas around the park.

Keywords: Potential threats, human activities, conservation, management, protected area

INTRODUCTION

Globally, biodiversity conservation and wildlife management efforts have been severely hampered by anthropogenic pressures (Mammides, 2020; WWF, 2020). The most significant

direct causes of biodiversity loss are probably changes in land/sea use, pollution, invasive species, climate change, and direct exploitation of natural resources (IPBES, 2019). One of the strategic responses to these multiple human pressures on ecosystems, is establishment of protected areas (PAs) (Gaston *et al*., 2008). *In situ* conservation in the original habitat- is the most established form in Africa (Mugabe & Clark, 1998). Establishment of *in-situ* conservation areas has been widely practiced in Africa since the 1940s, the time that loss of biological resources started receiving international attention (Kumar & Asija, 2000; IUCN-UNEP-WWF, 1980).

A protected area (PA) is described as a clearly defined geographic area that has been recognized, committed to, and maintained through legal or other efficient methods to promote the long-term protection of nature and the related ecological services and cultural values (Dudley, 2008). PAs are crucial for maintaining biodiversity, supporting the majority of national and local conservation programs (UNEP-WCMC *et al*., 2018).

Formal protection of wildlife resources in Ethiopia started in the 1960s and the Awash National Park (ANP) was established in 1969, being the first designated and legally recognized park in the nation. The establishment of this and other conservation areas was a success story. Despite this fact, these older PAs have been under heavy anthropogenic pressures and are threatened by various man-made activities (EWCA, 2018; IUCN ESARO, 2020).

With increasing human population and associated anthropogenic pressures, the rich wilderness of the park has come under serious threat. The man-made activities that mainly include overgrazing, invasive species, mainly human-induced *Prosopis and Parthenium species* encroachment, and expansion of cultivation and settlements have been threatening the wild habitats of the PA and as a result, the distribution and populations of many wild animals have been dramatically changing and declining (Zerga, 2015; Gebremedhin & Yirga, 2005; Jacobs & Schloeder, 1993). The formerly critical natural habitats and the potential wildlife resources have been dwindling overtime and some species have gone locally extinct (EWCA, 2018; Temesgen & Warkineh, 2018; Vreugdenhil *et al*., 2012). The PA under study had largely failed to achieve its conservation objectives.

There was, therefore, a need of urgent action to reverse the then critical problems of ANP, aimed at ensuring sound conservation of the threatened species and other principal ecosystem components of the PA. As part of this effort, re-demarcation of the conservation area has been underway since 2012 taking into account the ecological, social and economic conditions of the PA (Negarit-Gazette, 2015; EWCA, 2018). Accordingly, the ANP was re-demarcated and legally re-recognized in 2014 in order to achieve its multi-faceted conservation objectives. The re-demarcation was undertaken by excluding considerable areas which were considered as habitats highly affected by anthropogenic activities and the process was carried out through active participation of all stakeholders, including the community since the initial designation of the PA was undertaken without involvement of the local community (EWCA, 2018).

One of the main objectives of re-demarcating the national park was to protect and safeguard the wildlife species of conservation concern and their habitats through addressing their potential threats (Negarit-Gazetta, 2015; EWCA, 2018). Beisa Oryx (*Oryx beisa beisa*) and Soemmerring's gazelle (*Nanger soemmerringii*) and African lion (*Panthera leo*) are the threatened and key species conserved in ANP. According to the recent revision of the IUCN Red List Categories and Criteria (IUCN, 2022), every taxon in the world may be categorized into one of nine distinct groups that range from extinct and critically endangered to data deficient and not evaluated ones. Accordingly, Beisa oryx (*Oryx beisa*

beisa) is considered to be endangered species under criteria A2ad and C1. It is listed as Endangered as numbers have declined by an estimated 56 % (from 26,000 to 12,000 individuals) over the past two decades (IUCN SSC Antelope Specialist Group, 2018). Using the same analysis, African lion (*Panthera leo*) and Soemmerring's gazelle (*Nanger soemmeringii*) are considered to be Vulnerable species under criteria A2abcd and C1, respectively (Bauer *et.al.,* 2016; IUCN SSC Antelope Specialist Group, 2016).

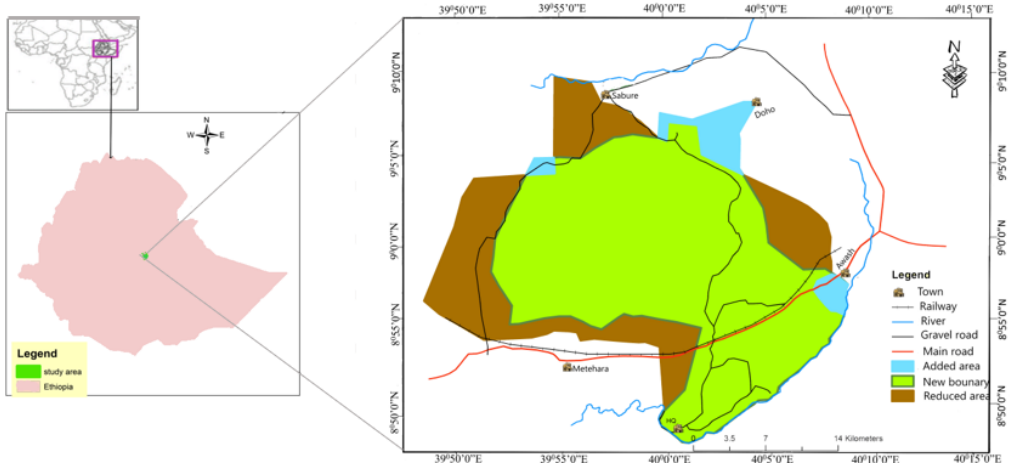
The above-mentioned threatened species are considered as indicators for threat reduction and ecosystem health of the Awash landscape in general and the status of wild mammals of the park in particular. However, there were considerable challenges to obtain up-to-date and reliable information on the trend of the threatened species and their potential anthropogenic threats after re-demarcation of ANP though it was generally reported that potential threats have been persisting (Mengist, 2020; Biru *et al*., 2017; Wale *et al*., 2017). This study has therefore examined and documented the perceptions of the local communities about the status of its anthropogenic threats to ANP and the impacts of the conservation measures that have been practiced since re-demarcation of Awash National Park on and trend of the threatened species (Beisa oryx, African lion and Soemmerring's gazelle).

METHODS

Study Area

The study area includes ANP and its surroundings. The Awash National Park which is named after the Awash River, the second longest river (about 1200 km) in Ethiopia. It is located in the Great Rift Valley System of Ethiopia at the southern edge of the Afar Triangle (Meuer & Moreaux, 2017; EWCA, 2018). Geographically, the Park has a north-south extent of just more than 30 km from 9°08'07" N to 8°49'57" N latitude and a west-east extent of almost 35 km from 39°51'15" E to 40°09'54" E longitude. ANP is presently reduced to an area of 591 km^2, from 756 km^2 following the recent re-demarcation and legal designation (Negarit-Gazetta, 2015). Subsequent to the re-demarcation, considerable areas of the ANP (214.4 km^2) were excluded while some potential wilderness areas (39.6 km^2) were included into the present status of the park (Fig. 1).

Fig. 1: Study area, and former and present boundaries of ANP



Awash National Park and its surroundings are characterized by a semi-arid climate (precipitation < 900 mm/year) and a bimodal pattern of rainfall. Short rainy season is anticipated between February and May, with the primary rainy season lasting from July through August. Between the end of October and the beginning of January is the dry season. The monthly minimum and maximum temperatures are 13.8 and 36.5 °C, respectively, with the mean yearly temperature being around 25.8 °C (EWCA, 2018).

The overall vegetation type that covers the largest part of ANP is classified as Acacia-Commiphora woodland, bushland and grassland (Friis *et al*., 2010; FAO, 1965). ANP comprises habitats for various important wildlife species, including those categorized as threatened. The lowlands are renowned for their varied ungulate populations including Beisa oryx (*Oryx beisa*), Soemmerring's gazelle (*Nanger soemmeringii*), Salt's dikdik (*Madaqua salitiana*), Greater kudu (*Tragelaphus strepsiceros*), Lesser kudu (*Tragelaphus imberbis*) and Common bushbuck (*Tragelaphus scriptus*) as well as various species of large carnivores such as Lion (*Panthera leo*), Leopard (*Panthera pardus*), Spotted hyena (*Crocuta crocuta*) and Stripped hyena (*Hyaena hyaena*) (Gebretensae & Messele, 2022; Gebretensae & Kebede, 2022; EWCA, 2018; Meuer & Moreaux, 2017; Gebremedhin & Yirga, 2005; Jacobs & Schloeder, 1993).

The large majority of the community in the rural areas are the pastoralist Afar and Oromo tribes. A majority of them are pastoralists, maintaining permanent settlements while moving their animals seasonally to exploit pastures away from the permanent settlement locations and the rest are agro-pastoralists (Scott, 2019; Jacobs & Schloeder, 1993).

Data collection

Questionnaire: Semi-structured questionnaires (with both closed- and open-ended questions) were used to collect data for the study. The total sample house hold (HH) for the survey was calculated using the following formula (Kothari, 2004): $n = z^2*p*q*N/e^2(N-1) + z^2*p*q$, where; N (total population size) = 1905, n (sample size) = 320, e (level of precision) = 0.05, z (the value of the standard variate at 95 % confidence level) = 1.96, p = sample proportion (0.5), and q (1- p) = 0.5. Accordingly, a total of 320 (n=320) members of households who were living in the eight kebeles (set of villages) adjacent to ANP, namely Gelcha-Ajotere, Benti, Ledi-Fate, Kobo, Dudub, Deho, Wasero and Alibete, were systematically (every third house) selected for the interview. They were interviewed taking into consideration four main components: i) socio-economic; ii) occurrence of potential threats; iii) status of the anthropogenic threats; and iv) level of severity of the identified anthropogenic threats. Training was provided for park staff who were fluent in the local languages on how to deal with the questionnaire forms. The survey was conducted between December, 2022 and August 2023. Prior to this, preliminary survey was conducted to identify the potential anthropogenic threats and assess the ecological and socio-economic conditions in the study area.

To investigate awareness of local people about the prevalence of anthropogenic threats to the park, the existence of the ten identified human-induced threats were measured by asking the respondents to indicate whether they consider the threat type "as existing problem or it is not a problem in ANP". Moreover, some socio-economic factors, such as sex, age, distance from the park boundary, direction of location of the respondents were considered to examine their relationships with the awareness of the local people about the threats. To examine the status of anthropogenic threats to the park before and after re-demarcation, we measured the trend of the threats by asking the respondents to indicate their opinion taking into account three options ("decreasing" or "no change" or "increasing"). We also examined the ANP's

threat level by applying the non-expert threat assessment approach and asking the respondents to rank the threats by putting 1 to 4 ordinal scales (1=low, 2=moderate, 3=high, 4=severe/extremely high). Furthermore, the interviewees were asked their perception about the ecological significance of wild animals in the park.

Besides, key informant interviews and focus group discussions were conducted with government and NGO officials and experts that include EWCA and ANP officials, Wereda and Kebele council members. Wereda is the second bigger administrative unit to Kebele, which is the smallest administration unit in Ethiopia.

Sample and total counts: Vehicle-based surveys were conducted between August 2023 and July, 2024 in both seasons to determine present density, distribution and encounter rate of the threatened species conserved in ANP. A 4WD vehicle with a couple of observers in opposite sides were driven along the systematically set 7 transect lines that range from 5 to 12 km in length. The vehicle was driven with a steady speed that did not exceed 25 km per hour as used by Keeping *et al*. (2018) and a fixed sighting distances of 200 m for diurnal (day time) survey and 100m for nocturnal (night time) survey were used as adopted by Durant *et al*. (2011). The starting and ending points of each transect were provided using Garmin GPS device to navigate and collect the required data and during the night time survey, strong spotlight was used to detect the target wild animals. Densities of the target species were calculated using the formula Di= ni/2wLpi; where ni is number of individuals observed; L is length of the transect length; and Pi is probability of detecting the individuals within the sight distance (w). Whereas, encounter rate was determined by dividing the number of recorded target species by the total distance travelled in km (1098 km = 54.9 km *10 times* 2 seasons). Furthermore, in order to determine the population size of the threatened antelopes and compare the census results (secondary and currently collected data through the same method) before and after re-demarcation of the PA, a total count was deployed by dividing the habitats of the target species into blocks.

*Indirect Evidences***:** Indirect evidences such as foot prints, scats, droppings, caraccas and vocalization were recorded to determine the spatial distribution (presence or absence) of the target species through walking and driving along the transect lines.

Besides, Management Effectiveness Tracking Tool (METT) as adopted by WWF and IUCN-WCPA (WWF, 2007) was used to determine the effectiveness of the conservation and management measures practised by ANP following its re-demarcation in order to address the prevailing anthropogenic threats. METT that comprised of all six elements (context, planning, inputs, processes, outputs and outcomes), incorporated in the 30 questions and supplementary questions was deployed. In this regard, the old version of assessment form for METT was filled objectively by the assessors (five management members of the park) to compare the METT scores of ANP before and after re-demarcation of ANP.

Data Analysis

Analysis was carried out using SPSS (Version 26) software. Descriptive statistics were used to quantify and describe the characteristics of the data and threat levels. The variations among the socio-economic characteristics of the respondents in awareness about prevalence of the identified anthropogenic threats was tested using χ^2 test. The association between the status/trend of each anthropogenic threat after re-demarcation of the PA and the indicated levels of each anthropogenic threat was determined by performing a Pearson Correlation test (as the sample size was large enough).

Besides, relative threat factor severity index (RTFSI) was calculated following Kiringe & Okello, (2007), using the formula: RTFSI = (The mean score for a particular threat factor) /

(The maximum possible score, 4), and a ranking system based on RTFSI was used to show which of the threat factors were more serious in the PA. The RTFSI can take any value (score) ranging from 0 to 1, with RTFSI score of 0 meaning that threat factor is non-existent and 1 very high prevalence/severity.

Analysis of T-test was deployed to check the significance of variation of encounter rates and densities of the target species among the habitat types. In addition, Wilcoxon signed ranks test was used to compare the METT scores before and after re-demarcation of ANP.

RESULTS

Socio-economic characteristics of respondents

Out of the 308 available that were for analysis, the majority (75 %, n = 231) of the respondents were males with 36 % (n = 111) within the age category of 36–45 years, followed by those within 25–35 years (27 %, n = 83); 4 % (n = 12) and 11 % (n = 34) respondents were below 25 and over 50 years, respectively. A considerable number of respondents (*n* = 136, 44 %) were located close to ANP's boundary (<2 km) and 98 (32 %), 30 (10 %), and 24 (14 %) respondents were situated between 2 – 4 km, 4.1- 6.1 km and 6.2 – 8 km, respectively. While 173 (56 %) of respondents were located in the southern and southwestern direction of the park (areas inhabited by Oromo ethnic groups), 135 (44 %) respondents were from the northern and north eastern direction (areas inhabited by Afar ethnic groups). A total of 236 respondents (77 %) were illiterate and majority (61 %) of them were pastoralists, who did not practice cultivation while the rest owned cultivated land ranging between 0.5 and 6 ha. Half of the respondents (n = 154,) had average monthly income of between 1201 and 2300 ETB (USD 22 - 42, for 2023).

Awareness about the prevalence of anthropogenic threats and perception on wild animals

Almost all respondents considered deforestation (n = 304, 99 %), livestock encroachment (n = 303, 98 %) and settlement expansion (n = 294, 96 %) as problem of the park, while a majority of the respondents recognized road kill (n = 264, 86 %), waste dumping/pollution (n = 258, 84 %), fire (n = 249, 81 %), cultivation expansion (n = 232, 75 %) and human-induced invasives species (mainly *Prosopis juliflora*) expansion (n = 226, 73 %) as other challenges of ANP. On the other hand, majority of the respondents did not consider poaching (n = 241, 78 %) and mining (n = 237, 77 %) as threat to the park. Despite their increased awareness about ever-escalating anthropogenic threats, most of the respondents (89.6 %, n = 276) agreed that the presence of wild animals in ANP is important for healthy ecosystem.

Statistically, there was significant difference between direction of location of the respondents in their awareness about incidences of cultivation expansion (χ^2=60.96, df=1, P<0.05), waste dumping (χ^2=18.96, df=1, P<0.05), deliberately set fire (χ^2=18.80, df=1, P<0.05) and human-induced invasives species encroachment (χ^2=64.63, df=1, P<0.05). There was also significant difference among the age groups of the respondents in recognizing the occurrence of the following anthropogenic threats to the park: livestock encroachment (χ^2=19.38, df=1, P<0.05), waste dumping (χ^2=61.32, df=4, P<0.05), deliberately set fire (χ^2=58.94, df=4, P<0.05), and human-induced invasives species (χ^2=18.89, df=4, P<0.05).

Status of anthropogenic threats to the park after re-demarcation

Majority of the respondents were in concurrence that deforestation (n = 299, 97 %), livestock encroachment (n = 293, 95 %) have increased after re-demarcation. Most respondents also considered settlement expansion (n = 274, 89 %), cultivation expansion (n = 248, 81%), expansion of invasives (n = 249, 81 %), rod kill (n = 138, 45 %) and waste dumping (n = 136, 44 %) to have increased following re-demarcation. Conversely, considerable number of respondents reported that the status of poaching (n = 226, 73 %) and mining (n = 162, 53 %) has shown no change after re-demarcation of the park (Table 1). Considering the responses received on trend for all identified anthropogenic threats, majority of the respondents (58 %) indicated that the anthropogenic threats were increasing while some of the respondents (29 %) perceived no change and a minority proportion (13 %) considered the threats were decreasing, following re-demarcation of ANP.

Table 1: Response on status of anthropogenic threats to the park after re-demarcation

Threat type	Increasing	No change	Decreasing
Deforestation	299	2	7
Livestock encroachment	293	9	6
Settlement expansion	274	27	7
Invasives expansion	258	50	0
Cultivation expansion	248	33	27
Road kill	138	120	50
Waste dumping	136	131	41
Fire/deliberate	130	129	49
Poaching	7	226	75
Mining	7	162	139

Levels of severity of the identified anthropogenic threats

Overall, the respondents held mixed opinion regarding the level of threat severity. Majority of the respondents indicated that deforestation (n = 259, 84 %), livestock encroachment (n = 187, 61 %), settlement expansion (n = 151, 49 %) and cultivation expansion (n = 141, 46 %) are considered as severe/extremely high threats. On the other hand, a sizable number of respondents also recognized expansion of invasives (n = 139, 45 %) under the high threat level. In contrast, a majority categorized mining (n = 291, 95 %), poaching (n = 273, 87 %), fire (n = 175, 57 %) and road kill (n = 174, 57 %) under low/negligible level of threat.

From the threat factors affecting ANP, deforestation was found to be the highest (0.94) threat factor index while livestock encroachment, settlement expansion and cultivation expansion had a threat index of 0.85, 0.80 and 0.70, respectively (Table 2). The rest six (60 %) threat factors had a threat index of 0.61 and below.

The Pearson Correlation test reveals that there were positive and highly significant relationships between the status (trend) of the following anthropogenic threats to the park and their respective levels (with critical P value at 0.01): Cultivation expansion (r = 0.521), livestock encroachment (r = 0.249), settlement expansion (r value = 0.405), deforestation (r = 0.325), road kill (r = 0.700), waste dumping (r = 0.277), fire (r = 0.713) and invasives expansion (r = 0.316). However, there were neither positive nor significant correlations between the trends and threat levels of poaching and mining.

Table 2: Mean score of the threat factors and relative threat factor severity index (RTFSI) of the identified anthropogenic threats (where RTFSI score ranges from 0 to 1)

Identified key threat factor that affects ANP	Mean score of the threat factors	Relative threat factor severity Index (RTFSI)
Deforestation	3.74±0.68	0.94
Livestock encroachment	3.41±0.87	0.85
Settlement expansion	3.19±0.96	0.80
Cultivation expansion	2.81±1.27	0.70
Invasives expansion	2.42±0.78	0.61
Road kill	2.21±1.43	0.55
Poaching	1.31±0.88	0.33
Waste dumping	2.15± 1.40	0.54
Fire/deliberate	2.18±1.41	0.54
Mining	1.07±0.36	0.27

Encounter rate, spatial distribution, density and abundance of the target species

The transects were laid out along the four habitat types that included mixed open grassland and wood land plain areas, wood land, bushland escarpments and wetlands and galleys covered by dense canopy vegetation. The encounter rate of Beisa oryx and Soemmerring's gazelle was found to range from 0.074 ± 0.005 and 0.006 ± 0.0008 km^{-1}, respectively, in mixed open grassland and wood land plain areas to nil (0) in the remaining habitat types. Whereas a relatively higher encounter rate of African lion (0.003 ± 0.0003 km^{-1}) was recorded in the other three habitats (wood land, bushland escarpments and wetlands) and neither direct nor indirect information indicated existence of this species in the southern part of ANP (Fig. 2).

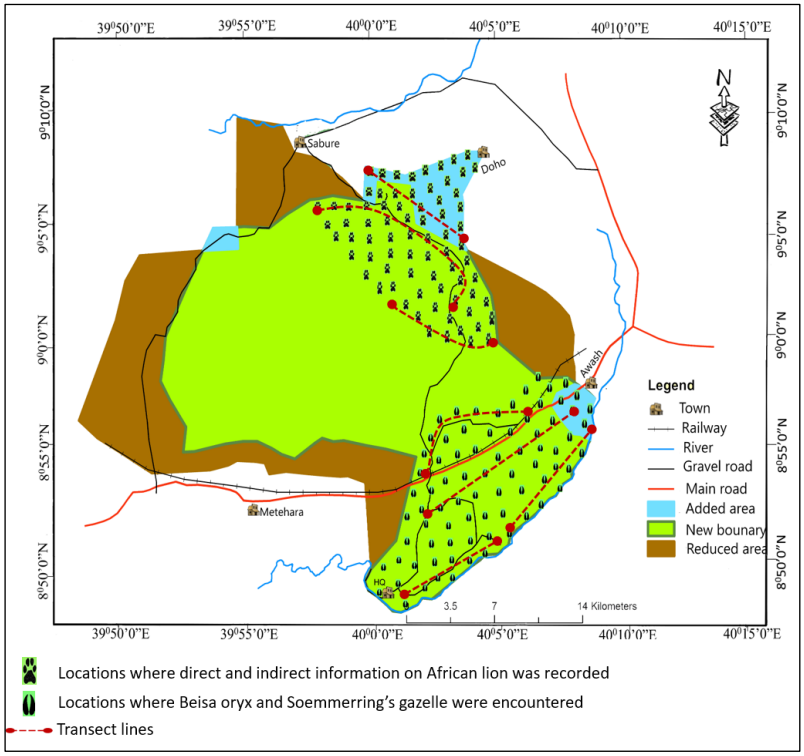
Analysis of data collected using distance sampling indicated that the estimated densities of African lion, Beisa oryx and Soemmerring's gazelle were 0.014 ± 0.001, 0.184 ± 0.011 and 0.016 ± 0.002 individuals km^{-2}, respectively. According to the result of total count in four blocks of the open grassland and wood land plain areas, the abundance of Beisa oryx and Soemmerring's gazelle was 68 ± 4.7 and 8 ± 1.35, respectively. Considering one third of ANP was a relative suitable habitat for Beisa oryx and Soemmerring's gazelle, their estimated populations based on these extrapolated densities were half (50 %) of the result of the total count.

Statistically, analysis of t-test has also shown that the encounter rate and density of the species under study varied significantly among the habitat types ($t = 8.334$ and $t = 8.287$; $df = 20$; $P < 0.001$).

Management effectiveness tracking tool (METT) score

The METT score obtained through the assessment conducted in 2011(EWCA, 2011) was 40 % and there was a difference of 7 % as compared to the recent (assessment filled in 2023) METT lower score of 33 %, which is classified as weak category of the score. This was also supported by the result of the Wilcoxon signed ranks test, which indicated that there was significant difference ($Z = -2.041$, $P < 0.05$) between the METT scores conducted before and after re-demarcation of ANP.

Fig. 2: Confirmed locations for the target species and transect lines



DISCUSSION

Awareness about the prevalence of anthropogenic threats

The association of some socio-economic characteristics on their knowledge about the anthropogenic threats varied from one threat to another. Significant difference was recorded between direction of location of the respondents in their awareness about incidences of cultivation expansion, waste dumping, deliberately set fire and human-induced invasives species encroachment in the study area. This appears to be mainly attributed to the prevailing changes in livelihood of the local communities that belong to different ethnic groups. The Afar ethnic group's villages border ANP from the north and northeast, while the Oromo ethnic group's communities border the park from the south and southwest. Hence, the fact that the life style of the Afar tribes inhabiting the areas opposite to Oromo communities, have been relatively changing over time from transhumant to agropastoralism livelihood as evidently reported by Biza (2014), Fenta *et al*. (2019), and Scott (2019), may account for the significant difference of their knowledge about prevalence of cultivation expansion, fire and invasives expansion. In most cases, expansion of cultivation is accompanied by deliberate fire to clear the vegetation (Bitew *et al*., 2022) and extension of invasive species. Expansion of invasives, specifically *Prosopis juliflora,* is the prominent problem throughout the Awash basin, in most areas inhabited by the Afar communities (Nanesa, 2021; Shiferaw *et al*., 2021; Mehari, 2015).

As human population increases the need for settlement areas and grazing land also increases (Temesgen & Warkineh, 2018) and hence members of these local communities

might have the opportunity to witness the real situation on the ground as indicated in the result of this study. However, this assumption differs from the findings of previous studies (Abrehe *et al*., 2020; Binlinla *et al*., 2014) which stated communities that are located closer to the borders of PA tend to encroach more in the conservation area.

Significant difference was recorded among the age groups of the respondents in understanding the prevalence of cultivation, waste dumping, deliberately set fire and human-induced invasives species. There were significant and positive relationships between age of respondents and their awareness about prevalence of these anthropogenic threats. In comparison to this, there was negative and significant relationships between age of respondents and their awareness about prevalence of livestock encroachment. In this regard, the elders are expected to be more informed about the aforementioned threats since they receive all information from all directions of their social set-up, while the youngsters are likely to have better knowledge about livestock encroachment as they are more engaged in livestock herding than their elders (Balehegn *et al*., 2019; Tesfay & Tafere, 2004).

On the other hand, most of the respondents recognized the significance of ANP and the presence of its wild animals for healthy ecosystem. This could be attributed to the values embodied in the integrated culture of the pastoralist communities that have an outstanding universal significance in ensuring wise use of the environment and biodiversity conservation (Gebretensae & Zerfu, 2023; Balehegn *et al*., 2019).

Status of anthropogenic threats to the park after re-demarcation

Considering the overall responses on the trend of the identified anthropogenic threats, majority of the respondents (58 %) indicated that the threats were on increasing trend while considerable number of respondents (29 %) assumed that there was no change and a minority proportion of them (13 %) considered that the threats were decreasing, following re-demarcation of ANP.

The result of this study is in line with the findings of other studies (Temesgen *et al*., 2022; Mengist, 2020; Abrehe *et al*., 2020; Tessema *et al*., 2019; Wale *et al*., 2017; Fekensa *et al*., 2016). These prior studies have reported that environmental changes of the natural ecosystems are more closely associated with the expansions of urbanization/settlements, cultivation and invasive species, and the ever-escalating deforestation and Ethiopia's PAs are highly affected by the adverse impact of these threats. Apparently, these anthropogenic pressures have been reported to be the main causes for habitat loss and fragmentation as well as dramatic decline of wildlife in and around ANP (Tessema *et al*., 2022; Temesgen & Warkineh, 2018; Biru *et al.,* 2017). Furthermore, the expansion of agriculture and infrastructures into the PA, which is accompanied by vegetation clearing and tree cutting for fuel wood and charcoal making is assumed to result in habitat fragmentation and loss and thus it has severe effect on ANP (Mengist, 2020; EWCA, 2018; Wale *et al*., 2017; Biru *et al*., 2017). Prior research in other PAs revealed that livestock encroachment is one of the major potential threats to wildlife and it has increased overtime (Fetene *et al*., 2019, Abrehe *et al*., 2020; Kebede *et al*., 2014; Mamo & Bekele, 2011), and ANP is not an exception in this regard (Mengist, 2020; Temesgen & Warkineh, 2018; Wale *et al*., 2017). A series of recent studies has indicated that the invasive species, particularly, *Prosopis juliflora* and *Parthenium hysterophorus* were expanding at increasing rate in ANP and its surroundings (Tessema *et al*., 2022; Nanesa, 2021; Shiferaw *et al*., 2021; Wale *et al.,* 2017; Mehari, 2015). Even though the speed breaks/bumpers along the highways which cross ANP and were established about a decade ago, road kill of various wild animals, including the key species conserved in the park, is a still persisting problem in the PA due to an increase in traffic flow

(Tessema *et al*., 2022; UNCTAD, 2018). In a similar scenario, since ANP is situated close to the ever-expanding urban areas as well as the main highways, waste dumping/pollution is one of the prominent problems of the park (Mengist, 2020; Temesgen & Warkineh, 2018; Wale *et al*., 2017). Majority of previous research has shown that deliberately set fire is another threat that destroyed the key habitats and main components of ANP, and if fire prevails after a prolonged drought, it changes the vegetation dynamics and thus deteriorates the habitat quality of the area (Bond & Archibald, 2003; Nieman *et al*., 2021). In contrast, considerable number of respondents stated that the status of poaching and mining has shown no change after re-demarcation of the park.

The key informants and focus group discussants also confirmed that all of the threats indicated above have been increasing over the last ten years. In particular, the officials of ANP and other concerned local offices expressed their bitter feelings that the Awash town is expanding at an alarming rate beyond the boundaries of the park without taking into consideration its master plan. They also equally affirmed that there were no recent reports of poaching and mining (extraction of selected construction materials). This assertion, however, differed from the findings of Wale *et al*. (2017), which reported that illegal hunting is common problem in ANP and other eastern Ethiopia PAs.

Levels of severity of the identified anthropogenic threats

The score of the threat factors and the positive and significant correlations between the trend and threat level of the anthropogenic activities is mainly attributed to the existing facts discussed above. The growing need for fuelwood, building materials, agricultural investments, and other purposes in the middle Awash basin, is considered as one of the anthropogenic activities to account for the loss of forest and the entire vegetation cover in exception to invasive species (Bitew *et al*., 2022; Tessema *et al*., 2022; Menbere, 2021; Oljirra, 2019).

Urbanized forms of settlements around the farms and along highways are on the increase. This in turn may affect the trend in the utilization of trees and their products since demand on tree products increases with increasing urban population and reliance on the woody biomass for fuel (Menbere, 2021; Wassie, 2020; Genet, 2020; Oljirra, 2019; Fenkesa *et al*., 2016). This increased reliance is not only due to expansion of urbanized centres and settlements but also due to increased transportation of tree products to other main towns of the country. The existence of the Addis-Djibouti main highway through which about 1000 trucks, mostly six-axle truck/trailer combinations travel per day (UNCTAD, 2018), can undoubtedly escalate the demand for fuel wood and charcoal production (Wassie, 2020; Fetene *et al*., 2019). Deforestation is, therefore, the highest in areas closer to town and roads where the transport cost for tree products is low. The focus group discussants have also consistently identified use of charcoal and firewood as major cause of deforestation.

In similar scenario, competition between local community for cultivation and grazing lands outside the PAs has been intensified overtime (Bitew *et al*., 2022; Fetene *et al*., 2019; Kebede *et al*., 2014). Expansion of sugar cane plantations and other large-scale farms in the Awash basin, has reduced grazing land, thereby intensifying degradation of livestock range lands and forcing pastoralist communities to use PAs (Tessema *et al*., 2022). On the other hand, rangeland degradation resulting from climate change, overgrazing, bush/invasives encroachment and drought has grown more intense (Wassie, 2020; Fenta, 2019; Mehari, 2015). Thus, with dwindling and fragmentation of the rangelands, livestock encroachment into the ANP has become eminent, resulting in adverse impact on its key habitats.

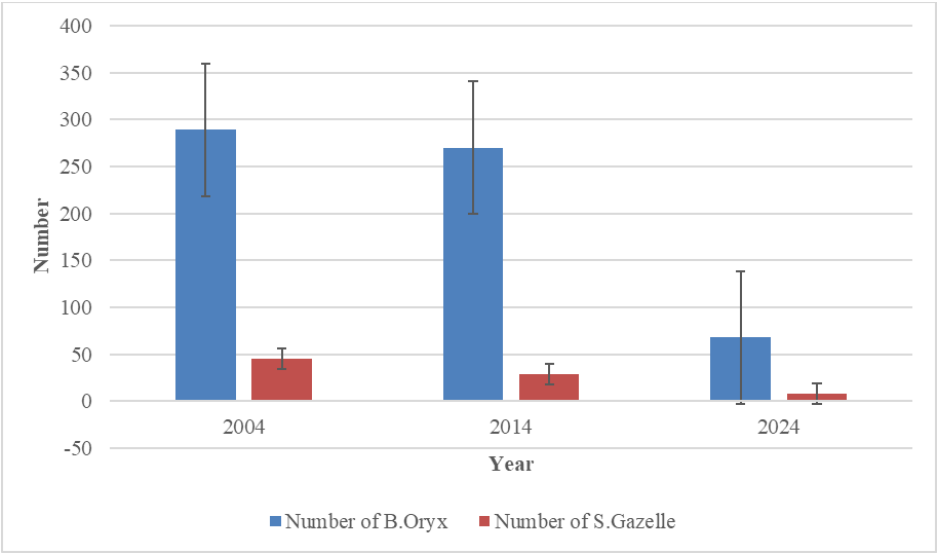
The facts discussed above reveal with no doubt that there is strong interdependence among the major anthropogenic threats to ANP. This link is not new. Similar observations have been

made in previous studies (Asefa *et al*., 2024; Temesgen *et al*., 2022; Menbere, 2021; Mengist, 2020; Abrehe *et al*., 2020; Temesgen & Warkineh, 2018; Biru *et al*., 2017; Wale *et al*., 2017), reported that the causes for substantial alteration of natural habitats in many PAs of Ethiopia are agricultural expansion, deforestation, overgrazing and expansions of settlement and invasive species.

Encounter rate, density and abundance of the target species

Considering the trend of distribution and abundance of the three species over the last decades, the results of the study revealed that there was dramatic decline in populations of Beisa oryx and Soemmerring's gazelle (Fig. 3) even though their range remains the same (Fig. 4).

Fig. 3: Trends in abundance of Beisa oryx and Soemmerring's gazelle based on total count result conducted in 2004, 2014 and 2024; Sources: Enawgaw (2005), Gebremedhin and Yirga (2005), ANP (2023), present study (2024)



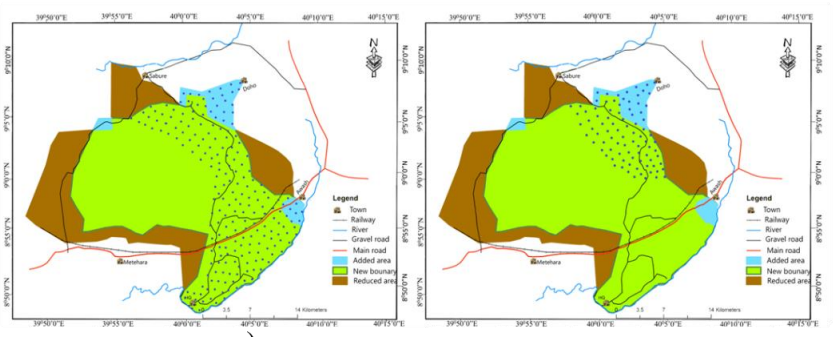
In the case of African lion, it was not possible to compare its present abundance with the previous ones due to lack of data on its density in the past. However, there are previous reports (ANP, 2023; EWCA, 2018) which indicated that African lion was widely distributed throughout all habitats, including the southern part of ANP. Thus, comparison of its distribution has shown that the African lion's home range has significantly shrunk where its range is currently restricted to the northern part of the park (Fig. 4).

Therefore, regardless of the efforts made to re-demarcate and practice conservation measures, the problems related to habitat loss and degradation in the ANP have been persisting. The potential anthropogenic threats that have resulted in deterioration of natural habitats and decline in populations of key species conserved in the area have continued and are increasing at an alarming rate. This is consistent with the previous reports discussed above (under section Status of anthropogenic threats to the park after re-demarcation and Levels of severity of the identified anthropogenic threats). However, most of them fail to link the existing anthropogenic threats with implementations of conservation and management

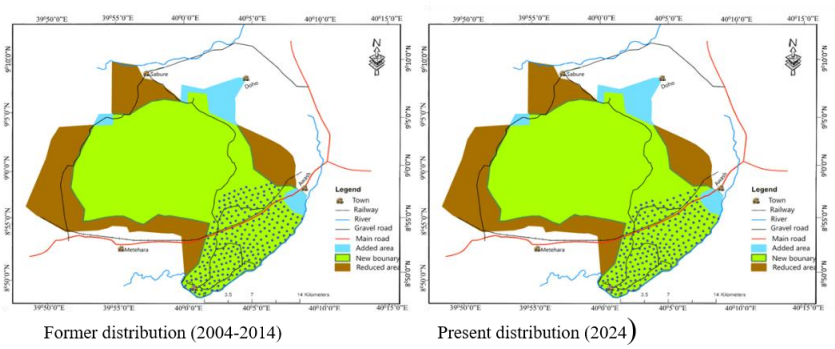
actions developed earlier, including executions of re-demarcation and general management plan of ANP. In other words, the preceding studies appear to neglect the interlinked factors of management and threats that directly affect the ecological effectiveness of PAs although management and threat reduction strategies are vital for assessing effectiveness (Pulido-Chadid *et al*., 2023). Apparently, majority of research on the effectiveness of PAs have concentrated on ecological aspects while paying less attention to their potential in reducing threats, which are one of the key drivers of wildlife loss (Virtanen *et al*., 2022; Harfoot *et al*., 2021; Gong *et al*., 2017). Taking the above-mentioned gaps into consideration, the ANP has not been able to address its management objectives and its potential threats even after re-demarcation and development of management plans. As a result, habitat degradation and loss as well as decline in populations of key and threatened species of wild animals have occurred (EWCA, 2018), albeit PAs like ANP are regarded as the most crucial tools for reducing anthropogenic pressures and derived threats to biodiversity (Pulido-Chadid *et al*., 2023; Schulze *et al*., 2018).

Fig. 4: Confirmed locations for target species before and after re-demarcation (2015); Sources: Enawgaw (2005), Gebremedhin & Yirga (2005), EWCA (2018), present study (2024)

(a) African lion (blue dots indicate confirmed locations)



(b) Beisa oryx and S. gazelle



Management effectiveness tracking tool (METT) sore and its implications

The METT score obtained through the assessment conducted in 2011(EWCA, 2011) and 2023 indicated that there was significant difference between the METT scores conducted before and after re-demarcation of ANP. The METT result (33 %) falls within the weak category (Leverington *et al*., 2010) and this indicates that management effectiveness of ANP is inadequate and declining over time.

One of the main objectives of re-demarcating the Awash National Park was to ensure sound conservation of the PA through addressing its potential threats (Negarit-Gazetta, 2015; EWCA, 2018). According to Council of Ministers Regulation No. 163/2008 and designation of ANP regulation No. 329/2014 (Negarit-Gazeta, 2015), all of the threats under study are strictly prohibited acts in a designated protected area, like ANP. However, the result of this study has shown that most of the anthropogenic threats to the park have been persisting and incidences of most of these illegal acts/threats has increased even after re-demarcation & redesignation of ANP. This may imply the driving factors for the potential threats were not addressed properly and the conservation measures taken so far to reduce the adverse impacts of deforestation, livestock encroachment, expansions of settlement, cultivation and invasives, and road kill on ANP have not been so effective. This was also supported by the declining result of the METT scores, which also indicated that there was significant difference between the METT scores before and after re-demarcation. Thus, re-demarcation by itself cannot be considered as an end to ensure sound conservation and management of ANP unless effective implementation of conservation actions is undertaken. Moreover, implementation of the previously proposed conservation measures has to take into consideration the dynamics related to the potential threats and associated contemporary management issues (Menbere, 2021; Salafsky *et al*., 2002).

CONCLUSION AND RECOMMENDATIONS

One of the main objectives of re-demarcating the ANP was to protect and safeguard the wildlife species of conservation concern and their habitats through addressing their potential threats. However, the result of this study has shown that major anthropogenic threats to the park have been persisting at varying degrees and the extent of majority of them had increased following re-demarcation. As a result, habitat deterioration and decline in populations of key and threatened species of wild animals conserved in ANP have dramatically increased. This may unveil the driving factors for the potential threats were not properly addressed and the conservation measures devised to reduce the adverse impacts of these threats have not been effectively implemented. Thus, re-demarcation and development of general management plan (GMP) by themselves cannot be considered as an end to ensure effective management of ANP and sound conservation of the threatened species unless effective implementation of conservation actions is undertaken. It is therefore recommended to: 1) Identify the main drivers for the core anthropogenic threats, devise effective and adaptive management systems and enable effective implementation of all programs of the GMP and associated conservation actions; 2) Enhance land use planning in areas around ANP; and 3) Launch targeted awareness creation programs regarding road-kill and waste damping.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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