Project Update: May 2023

INTRODUCTION

Invasive plants are the main key threats to biodiversity globally, they change ecosystem functions and have substantial economic effects (Marchante et al., 2010). Biological invasions can cause substantial negative environmental and socioeconomic costs in an invaded area as they can significantly decrease the existing ecosystem services (Simberloff, 2020). Insects on the other hand are among the key indicators of healthy ecosystems, and they perform an important role in maintaining an ecosystem functioning (Subedi et al., 2021). Invasive plants that become dominant in a new environment and have plentiful flowers with abundant nectar and pollens which can attract pollinators to exploit such flowers may later affect the diet and health of pollinators (Vanbergen et al., 2018). From socioecological perception, invasive species management normally requires a multi-stakeholder's approach which includes better knowledge of human scopes (Shrestha & Sharma, 2014). Involvement of local communities on invasive management frequently relay on levels of community awareness, their perceptions of the problem, species of the importance, best management approaches to targeted species, and incentives for management interference for communities (Shrestha & Sharma, 2014).

Most of public awareness towards invasive plants, management and effect of management on insect visitors which involved key stakeholders and other people has been conducted in developed countries (Novoa et al., 2017). To address this gap of knowledge, we involved 8 village members around the Mwiba area to respond to our questionnaires on the invasive plants' management and its associated effects on other parts of biodiversity which is the insect who are visiting flowers.

MATERIALS AND METHODS DATA COLLECTION

Field studies was conducted within the villages around at Mwiba area, formerly known as Makao Open Area, located in North-Western Tanzania between 03°22' S to 34°41'E to 34° 53'E (Ngilangwa et al., 2018) at Meatu District, Simiyu region, Tanzania. Mwiba covers an area of about 19,647 ha and borders the Ngorongoro Conservation Area Authority to the east, Maswa Game Reserve to the North, and Makao Wildlife Management Area to the Southwest. The average annual temperature ranges between 21 °C and 27 °C and precipitation of 750 mm to 915 mm with a bimodal rainfall pattern with short rains in November and December and long rains in March to May (Ngilangwa et al., 2018). Invasive plants like *Gutenbergia cordifolia* have recently invaded most of the Mwiba area and have become a concern in this area, but have been little documented (Mbundi et al., 2021). The aim of this outreach was to assess the local community's awareness and perceptions of invasive plant management and its effects on insect visitors around the Mwiba area.

The 8 selected villages were (Makao, Irambandogo, Sungu, Sapa, Mbushi, Shushuni, Lukale and Mwambagimu village) around Mwiba area, within Meatu District in Simiyu Region, Tanzania form the Makao Wildlife Management Areas (Makao WMA) and are within the Serengeti ecosystem which made them important areas

to be conserved. So, providing conservation education to these local community around Mwiba area will help in controlling the spread of *G. cordifolia* to more Protected areas like the Serengeti National Park which is close to these villages.

We offered incentives such as T-shirts, refreshments, Desmodium seeds, training on invasive plants, and their management impact on insect visitors etc. to encourage participation. Our results are exploratory due to the sample obtained within the study areas were those that were accessible to researchers rather than randomly allocated. The survey included 19 questions with some being adapted from formerly used tools recognized to be dependable (Oxley et al., 2016). Our survey had three objectives including invasive plants and insect visitors' awareness knowledge questions; attitude towards invasive plants management and its associated effects towards insect visitors; and about how and where they hear about invasive plants and insect visitors; all directed toward gathering demographic information, i.e., age, gender and education level (Waliczek, 2017). On the knowledge of invasive plants and insect visitors we examined the local skill to identify insect visitors and invasive plants by giving each respondent images of native insect individuals of Mwiba area visiting a flower as shown in (Fig 1.) and images of invasive plants species including invasive *G. cordifolia* as presented in (Fig. 2.). For the attitude toward invasive plants management and its associated effects towards insect visitors, respondents were given series of questions that assessed their attitudes toward management of invasive plants and also assessed if they know the effect of management on insect visitors.

DATA ANALYSIS

Data were analysed by using SPSS statistical package (version 22; IBM). We used descriptive statistics in summarizing the data collected. On the knowledge of invasive plants and insect visitors we assigned questions that aimed at collecting information on invasive plants species and insect visitors of around Mwiba area and the quantitative responses were summarized and complied in figures where frequencies and percentages were calculated. On the attitudes towards management of invasive plants and its effects on insect visitors, we asked if they agree that invasive plants should be managed if yes, we asked them to suggest which method should be used to manage invasive plants and also to mention the method which could negatively affect insect visitors. The knowledge of invasive plants and insect pollinators was assigned scores and graded based on the correctness of answers. The scores on knowledge of invasive plants had a scale of 0 to 25 while that of insect pollinator 0 to 10 with a higher score indicating greater knowledge and vice versa. The grades from these scores for both knowledge on invasive plants and insect pollinators are shown on Table 1. Pearson's Chi-squared Test ($\chi 2$) at $\infty = 0.05$ was used to analyse the relationship between awareness, knowledge, and attitude toward the management of invasive plants. The Kruskal-Wallis test was used to compare the knowledge of invasive plants among age groups and villages at a significance level of 0.05.

Honey bee (*Apis mellifera*)

Blister beetle (*Hycleus lugens*)

Picasso bug (*Sphaerocoris annulus*)

Hoverfly (*Asarkina africana*)

Citrus swallowtail (*Papilio demodocus*)

Blue emperor (*Anax imperator*)

Figure 1: Pictures of insect pollinators that were presented to the respondents for identification.

Gutenbergia cordifolia

Tagetes minuta

Lantana camara

Datura stramonium

Lonicera japonica

Leucaena leucocephala

Figure 2: Images that were given to the respondents to identify invasive plants around Mwiba area and Ngorongoro Conservation Area.

ETHICS CONSIDERATION

We obtained the permit from the Tanzania Commission for Science and Technology (COSTECH) to conduct this work through the Tanzania Wildlife Research Institute (TAWIRI). We then offered the permit to particular district, ward and village leaders. Before the questionnaire process, we got the written consent of all respondents to confirm their willing involvement. All respondent's names are unidentified to uphold confidentiality.

RESULTS AND DISCUSSION

A total of 160 respondents took part in the study, with 39% being men and 61% being women. Participants from each village and age group were fairly representative of the target population (Figure 3 and Figure 4). The highest level of education attained by the majority of participants (72%) was primary education, followed by secondary education (17%), no formal education (5%), college or university education (4%), and primary or secondary education combined with other types of education (2%). Most participants (68%) were farmers or peasants, followed by livestock keepers (13%), business owners or entrepreneurs (11%), employees (2%), students (<1%), and those with more than one main economic activity (6%).

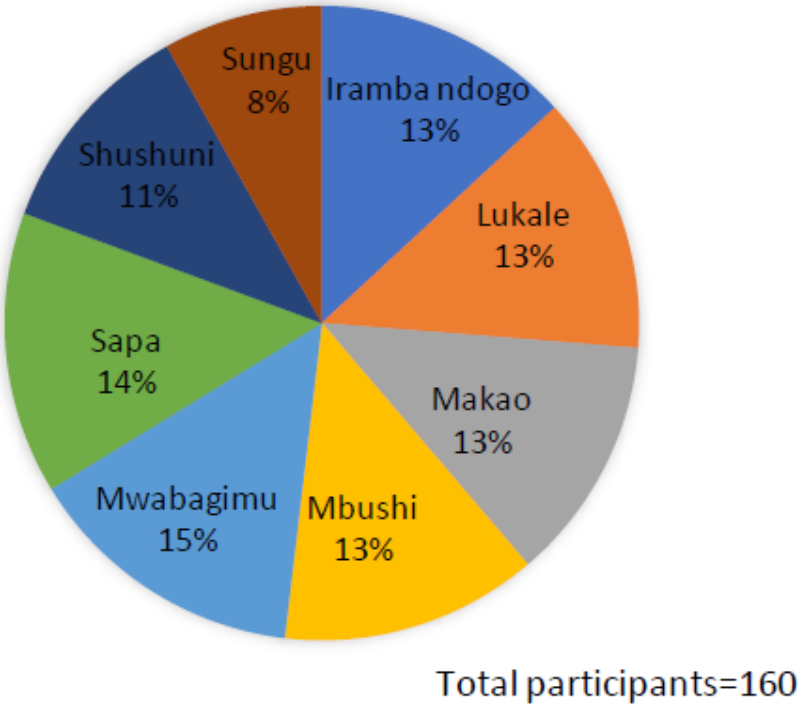

Figure 3: Participant proportions from eight sampled villages

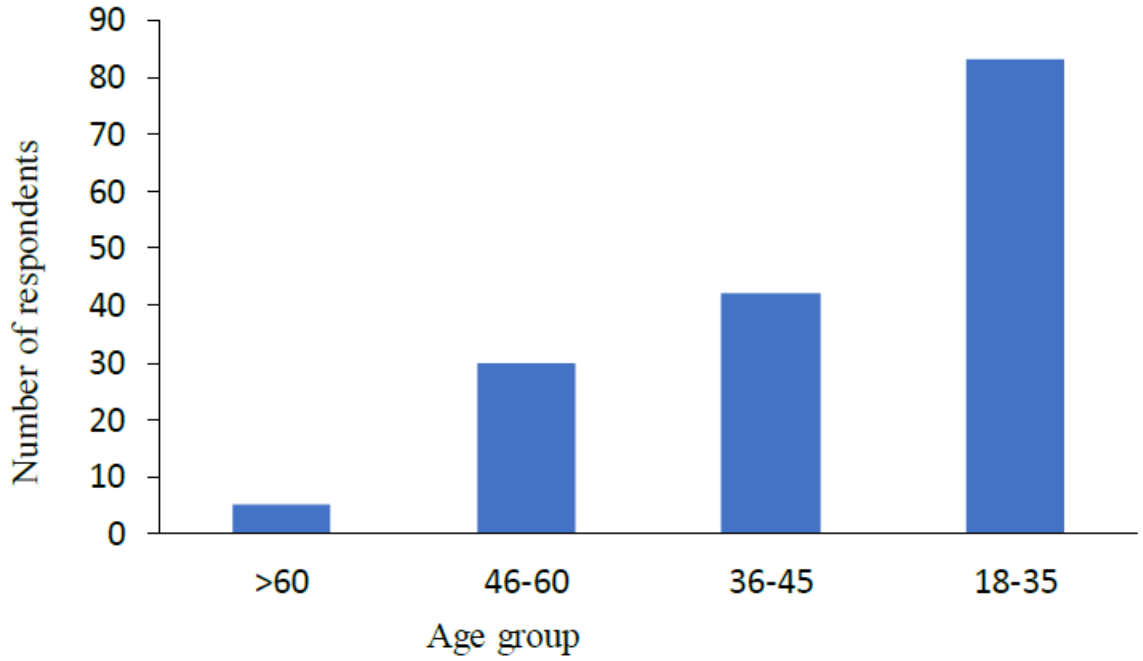

Figure 4: Number of participants from various age groups, totaling 160 participants.

AWARENESS AND KNOWLEDGE OF INVASIVE PLANTS

When we asked the question, "how informed do you think you are about invasive plants?" The majority of participants (71%) said they had been informed about invasive plants, while 29% were unaware of them. Additionally, 93% of those who were informed about invasive plants said that they had seen the presented invasive plants (Fig. 2), while only 7% had never seen them. And since the majority of participants were identified as farmers or peasants, the results indicated that invasive plants are more likely to be found in their farmlands. When asked about the negative effects of invasive plants, the majority (39%) said they reduce agricultural yields, followed by 8% loss of biodiversity, 8% competition with other plants, 2% infrastructure destruction, 1% reduced tourism activities, less than 1% increased drought, and 43% were unaware of any harm. Furthermore, because the majority of respondents were farmers, the most common negative impact of invasive plants was lower agricultural yields.

On the knowledge of *G. cordifolia* we assessed them with special questions, where the participants were asked to identify if it is an invasive plant and tell whether it has benefits or detriments. Most of the respondents (56%) said they knew the plant, 44% didn't know the plant while 35% of respondents identified it as invasive species, 4% said it was not an invasive and 61% had no answers. Most of the respondents (75%) did not know whether *G. cordifolia* has detriments, 21% identified it as detrimental and 4% said it has no detriments. Almost all of the participants who identified it as harmful identified crop destruction as the primary harm, with only a few identifying biodiversity losses. Furthermore, 65% of respondents were unsure whether it has benefits, 11% said it does, and 24% said it does not. Participants identified *G. cordifolia* benefits such as local medicine, mosquito repellent, ornaments, pollinators, food, and broom making. Generally, our findings showed that respondents' attitudes toward invasive plants were influenced by their level of

awareness (χ^2= 90.808, df = 2, p < 0.05). Furthermore, the knowledge of invasive plants was the same across age groups (χ^2= 6.3846, df = 3, p = 0.094), but significantly different across villages (χ^2= 37.737, df = 7, p < 0.05). These results on awareness and knowledge of invasive plants suggest that lack of knowledge and awareness on invasive plants like *G. cordifolia* is still a substantial reality and there is still a lot to be done!

KNOWLEDGE OF INSECT POLLINATORS AND ATTITUDES TOWARD THE MANAGEMENT OF INVASIVE PLANTS

Respondents were given six species of insect pollinators (Figure 1) from which they were required to identify with local names or any other names and asked to tell whether invasive plants (Figure 2) have negative impacts on these pollinators then answers were given to scores ranging from 0 to 10. The minimum score was 0, median 5 and maximum 10, while 5% of respondents scored 0, 13% scored 10 but also 45% of respondents scored below and 55% scored above the average. When asked whether the invasive plants had negative impacts on insect pollinators, the majority of respondents (53%) didn't know, 32% said invasive plants had and 16% said invasive plants had no negative impacts on insect pollinators. Regarding the benefits of insect pollinators, most respondents (39%) said they benefited from honey, followed by pollination (31%), food (6%), increased agricultural yields (4%) and 21% had no answers.

When asked if there was a need to control the invasive plants 56% agreed while 1% disagreed and 43% had no answers. The method to control invasive plants suggested by most participants (28%) was natural herbicides, followed by chemicals (17%), mechanical (11%) and biological control while 41% had no answers. Furthermore, when asked about the methods impacting negatively pollinators, most participants (28%) suggested chemicals, followed by natural herbicides, mechanical methods (9%) and biological control (3%) while 39% had no answers. In general, there was a significant relationship between respondents who knew a lot about invasive plants and those who knew a lot about insect pollinators (χ^2= 49.432, df = 16, p < 0.05). Similar to this, there was a significant correlation between respondents' knowledge and attitude toward managing invasive plants (χ^2= 46.263, df = 8, p < 0.05). These results suggest the view that once the public awareness towards invasive plants management and its effects on biodiversity increases, it might also intensify public support for the management of invasive species (Novoa et al., 2017).

SOURCES OF INFORMATION ON INVASIVE PLANTS AND INSECT POLLINATORS

When we asked about where the respondents obtain information concerning invasive species and insect pollinators, the most reliable source was media (Radio, Television etc.) with 26% of supporter respondents followed by environmental or conservation organizations (25%), schools and colleges (11%), elders (11%), agricultural seminars (11%), social networks (11%) and field training (6%). The environmental or conservation organizations scored second indicating the surrounding protected areas and organizations have put incentives to control invasive plants in villages.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study shows that the local community living adjacent to the Mwiba area has an inadequate level of awareness of invasive plants and their management despite the slight training that we gave them before giving them the questionnaire. Furthermore, this study shows that the community is willing to support management of invasive plant Mwiba area, however their perceptions regarding the effects of invasive plant management on insect visitors' area mixed. Therefore, we recommend that education and awareness-raising efforts should be increased to promote the importance of invasive plant management in the Serengeti ecosystem. This can be done through community outreach programs, workshops, and other educational initiatives. Additionally, we recommend that further research should be conducted to better understand the impacts of other invasive plant management on insect communities in the Serengeti ecosystem. This can be done through long-term monitoring and experimentation to determine the most effective strategies for managing invasive plant species in the area.

Figure 5: A project leader with the local members of Shushuni village which is among of the village around Mwiba area, this picture was taken after a training and questionnaire exercise.

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Supplementary materials

Table 1: Grades and scores based on knowledge of participants on invasive plants and insect pollinators.

GRADES	INVASIVE PLANTS	INSECT POLLINATORS	DESCRIPTION
A	20–25	8–10	Excellent
B	15–20	6–7	Very good
C	10–15	4–5	Good
D	5–10	2–3	Fair
E	0–5	0–1	Poor