Journal of Environmental Sciences and Technology

[ISSN 2958-1176]
Volume: 01 Issue: 01 | Oct-2022

JEST

# DISTRIBUTION OF PARTHENIUM WEED (*Parthenium hysterophorus*) IN NAKURU COUNTY, KENYA

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**Cite this article in APA**

Mutua, B. M., Chiuri, W., Ngure, V., & Kimani, V. (2022). Distribution of parthenium weed (*Parthenium hysterophorus*) in Nakuru County, Kenya. *Journal of environmental sciences and technology*, *1*(1), 48-57. https://doi.org/10.51317/jest.v1i1.295

OPEN ACCESS
A publication of Editon Consortium Publishing (online)

**Article history**
Received: 24.08.2022
Accepted: 26.08.2022
Published: 25.10.2022

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**Abstract**

This study sought to map the distribution of parthenium weed in Nakuru County. Field surveys were conducted in September 2021 using the quadrat method, whereby the road stretch between Naivasha junction and Kibunja was used as the main transect. Data on the presence or absence of parthenium weed was recorded, and the geographical coordinates were taken using a hand-held GPS receiver and loaded into ArcGIS 9.3 computer software for the development of a parthenium-distribution map. Data were analysed using IBM SPSS V. 28 statistical tool (SPSS Inc., Chicago, IL). Correlation analysis (at a 5% significance level) was used to show the relationship between the presence of parthenium weed and elevation, while descriptive analyses were used to determine the proportion of invaded quadrats. The results of this study revealed that parthenium weed was widespread in Nakuru County, with 79.2% of quadrats sampled invaded. The majority of parthenium weed invasions were reported in low-altitude regions (<1999 M ASL), especially those between Naivasha and Nakuru ($r = -0.507$, $P < 0.001$). This study showed that Nakuru County is threatened by parthenium weed due to its vast distribution. Therefore, the County Government of Nakuru should prioritise parthenium weed management to avert further spread.

**Key terms:** *Parthenium hysterophorus*, spatial distribution, Nakuru County.

## 1.0 INTRODUCTION

Invasive Alien Species (IAS) are living organisms introduced into new regions where they establish themselves, increase, and have detrimental effects on biodiversity, ecosystem services, and human livelihoods (Pratt et al., 2017; Early et al., 2016). Among the worse global plant species is parthenium weed *(Parthenium hysterophorus*), which is an aggressive invader in over 34 countries. Parthenium weed is an annual plant species that belongs to the Asteraceae family. The plant originates in South and Central America and has invaded Africa, Asia, and Australia (Bajwa et al., 2016). The weed was first reported in Kenya in 1975 (Njoroge, 1986) and later declared a noxious weed threatening human health, agricultural production and biodiversity (GoK, 2010). The current study documented the distribution of parthenium weed in Nakuru County, Kenya.

## 2.0 LITERATURE REVIEW

*Parthenium hysterophorus* L., commonly known as parthenium weed, is a plant of the Asteraceae family and a native of South and Central America. The weed is considered noxious and one of the world's most invasive plant species (Adkins & Shabbir, 2014). Parthenium weed is an annual plant that grows to a height of 2 metres under favourable climatic conditions. It has deeply lobed pale green leaves and tiny white flowers on the tips of the stems. A single plant can produce more than 25,000 seeds in its entire lifespan. The seeds have two slender, spoon-shaped white appendages and are small (1-2 mm), flattened, triangular, and dark brown to black (Adkins et al., 2018). The seeds can survive for four to six years, thus creating a prolonged life seed bank, which is a challenge to eradicate (Bajwa et al., 2016). Parthenium weed seeds are easily dispersed through the transportation of contaminated food grain, feed, and seed lots, attachment to machinery and vehicles, and attachment to packaging materials, water, animals, and wind which enables it to colonise new regions quickly (Mao et al., 2021; Shabbir et al., 2019). In addition, parthenium weed can grow in a variety of environmental conditions, including rainfall of more than 500 mm annually, average annual temperatures of 10 to 25 °C, and a soil pH of (2.5 to 10) (Adkins et al., 2018; Kaur et al., 2017). The reproduction ability is one of the most crucial biological traits for parthenium weed effectiveness as a weed. A season may produce four or more successive cohorts of seedlings, and flowering may begin as soon as four weeks after seedling emergence (Adkins et al., 2018). In favourable climates, the plants continue to flower for roughly six to eight months (Bajwa et al., 2016).

Parthenium weed is an aggressive invader that releases allelochemicals that poses a major threat to the ecosystem, biodiversity and human livelihoods. These allelochemicals inhibit the germination and growth of a wide variety of plant species, including native plants and different crop and pasture species. These characteristics are crucial for its invasion and persistence in a variety of native and non-native habitats (Adkins et al., 2018). Studies have revealed that parthenium weed has a negative impact on the diversity of plant species. According to Nigatu et al. (2010), species diversity and evenness decreased as parthenium weed invasion levels rose steadily, which substantially impacted community heterogeneity and distribution. In addition, the weed has severe effects on agricultural sustainability and productivity (Bajwa et al., 2016). According to several studies, parthenium weed causes significant crop yield losses. The weed infestation causes yield losses of up to 40% in many crops and reduces the production of forage by up to 90% (Gnanavel & Natarajan, 2013). In Nyando sub-county, Kenya, parthenium weed has a negative effect on the local plant diversity (Abuto et al., 2018). The weed also affects human health, livestock health, and the quality and quantity of livestock products (Mutua, 2014). The control is difficult because this allelopathic

plant is highly prolific and spreads very fast. Parthenium weed has been managed using a variety of techniques, including biological, physical, cultural, and chemical ones (Strathie & McConnachie, 2018).

Parthenium weed occurs as an alien invader in Africa, Asia, and Australia (Bajwa et al., 2016). In Africa, parthenium weed has invaded South Africa, Swaziland, Mozambique, Zimbabwe, Botswana, Egypt, Ethiopia, Uganda, Madagascar, Mauritius, Rwanda, Comoros, Djibouti, Kenya, Tanzania, Eritrea, Somalia, and Seychelles (McConnachie et al., 2011; Shabbir et al., 2019). Parthenium weed was unintentionally introduced into Kenya and Ethiopia in the early 1970s, presumably through tainted wheat seeds from Australia (Pratt et al., 2017). In Kenya, parthenium weed has spread to the western, eastern, and central regions, as well as the Lake Victoria Basin and Rift Valley (Tabe et al., 2022; Abuto et al., 2018; Mutua, 2014; Wabuyele et al., 2014; Njoroge, 1986). Parthenium weed, however, is projected to spread further because the country is climatologically favourable for new invasions (McConnachie et al., 2011). Parthenium weed is common in disturbed areas such as stockyards, around buildings, roadside and railway lines, and fallow agricultural lands due to the absence of interspecies competition (Strathie & McConnachie, 2018). This explains its prevalence along freshly renovated roads in Kenya (Abuto et al., 2018; Wabuyele et al., 2014). Therefore, this study sought to map the distribution of parthenium weed in Nakuru County.

## 3.0 METHODOLOGY

The study was carried out in Nakuru County. The county is among the 14 counties within the Rift Valley. The county bounders Laikipia to the north-east, Kericho to the West, Narok to the south-west, Kajiado to the South, Baringo to the North, Nyandarua to the East, and Bomet to the West. The county has 11 sub-counties/constituencies: Naivasha, Nakuru Town West, Nakuru Town East, Kuresoi South, Kuresoi North, Molo, Rongai, Subukia, Njoro, Gilgil, and Bahati. The county covers an area of approximately 7,498.8 $Km^2$ and is located between Longitudes 35.41 ° East or 35 ° 24′ 36″ East and 36.6 °East or 36 ° 36′ 0″ East and Latitude 0.23 ° North or 0 ° 13′ 48″ North and 1.16 ° South or 1° 9′ 36″ South. The major economic activities include agriculture, tourism, and financial services. Nakuru is an agricultural rich county whose background was shaped by the early white settlement schemes. The county's human settlement has been shaped by major transport infrastructure, i.e., the early colonial rail network and road A104. Nakuru County's climate is strongly influenced by altitude and physical features and has four major climatic zones, i.e., Zone I - IV. Zone IV covers areas with an altitude between 2300 m and 2700 m above sea level and receives rainfall of over 1400 mm per annum. This zone covers the Mau Escarpment, forming part of the Kuresoi North and Kuresoi South Sub-Counties. Zone III receives rainfall of between 1100 and 1400 mm per annum and covers areas with an altitude of between 1800 and 2300 m above sea level. This zone covers much of Kuresoi North, Molo, Njoro, Subukia, and Bahati Sub-Counties, which are very suitable for agricultural activities. Zone II occupies most parts of Nakuru County with a general elevation of between 900 m and 1800 m above sea level. Zone I has the lowest mean annual rainfall of about 500-800 mm per annum. This zone covers Gilgil and Naivasha Sub-Counties (GoK, 2018). Nakuru County experiences a bimodal type of rainfall, with long rains between April and June and short rains between October and November (Obiero et al., 2019). The county population is approximately 2,162,202 people with 1,077,272 males, 1,084,835 females and 95 intersexes (Kenya National Bureau of Statistics [KNBS], 2019). Nakuru County was ideal for this study because agriculture, one of the main economic activities, is currently under serious threat by the rapid and extensive invasion by parthenium weed.

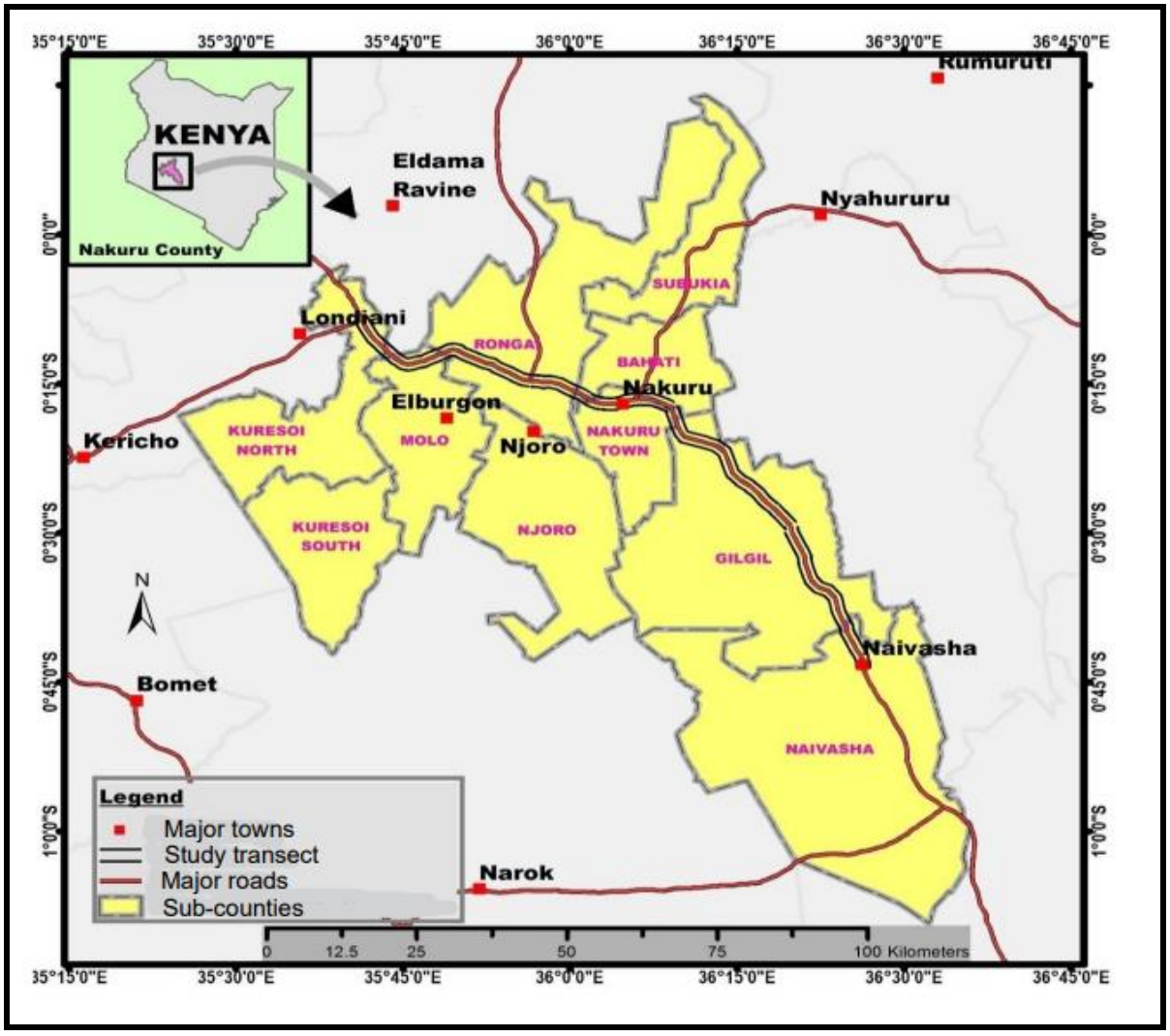


**Figure 1: Location of Nakuru County**
(Source: Survey of Kenya 1979 Topo Sheets and IEBC Shapefiles 2010)

**Research Design**

This study adopted descriptive research designs to address the research objectives. A descriptive research design that entailed field surveys was used to collect data on the spatial distribution of parthenium weed.

**Data Collection Methods**

Field surveys were carried out in September 2021 when parthenium weed was still growing. The road transect method was used to determine the spatial distribution of parthenium weed in Nakuru County. The Eldoret – Nairobi Road (A104) between the Naivasha junction (0°37'53.7 "S 36°23'15.7 "E) and the Molo junction (0°13'11.2 "S 35°44'10.4 "E) was used as the main transect (Figure 1). Data on the presence or absence of parthenium weed was collected using the quadrat method. A total of 96 quadrats (1 $m^2$) were laid at 1 km intervals along the road transect 30 m from the edge of the tarmac. Parthenium weed was considered to be present if at least one plant was observed within a quadrat. The geographical coordinates were taken using a hand-held GPS receiver, and the points were loaded into ArcGIS 9.3 computer software and developed into a parthenium weed distribution map.

**Data Analysis**

Data on the distribution of parthenium weed in Nakuru County were analysed using IBM SPSS V. 28 statistical tool (SPSS Inc., Chicago, IL) and Ms Excel 2013. The relationship between the presence of parthenium weed and elevation was shown using correlation analysis at the 5% level while descriptive analyses were used to determine the proportion of invaded quadrats. The Spearman Correlation Coefficient (R) was evaluated in linear correlations between parameters, and correlations were considered statistically significant at the 5% level.

**4.0 RESULTS AND DISCUSSIONS**

Out of the 96 quadrats sampled for the presence of parthenium weed, 76 quadrats representing 79.2%, had been invaded by the weed, while 20 quadrats (20.80%) were not invaded, as shown in Figure 2 and the distribution map (Figure 3).

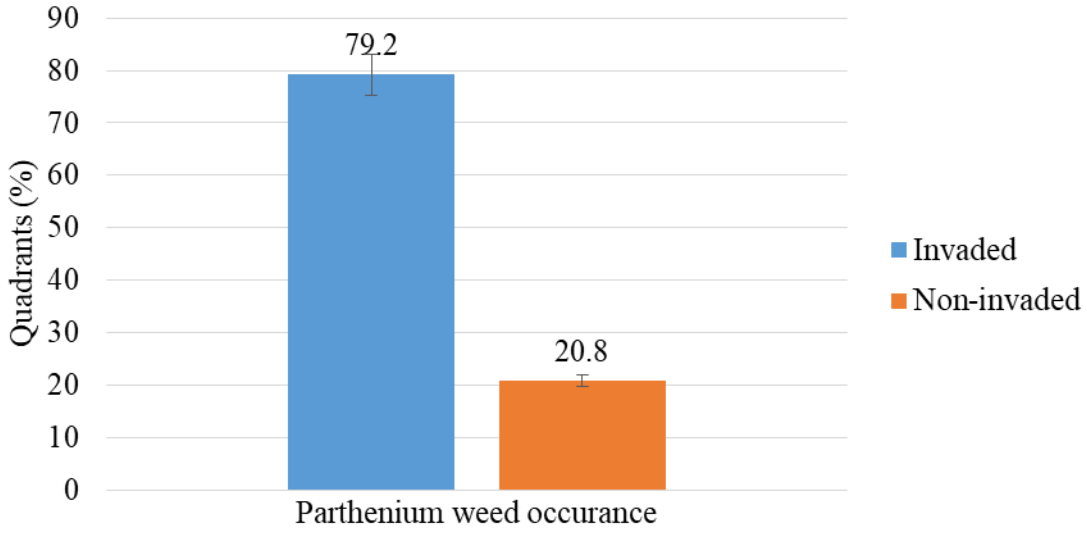


**Figure 2: The Proportion of Invaded and Non-Invaded Quadrats**

In the majority of the quadrats sampled, 79 occurred in areas below 1999 m ASL, while 17 occurred above 2000 m ASL. Data analysis revealed that parthenium weed was more prevalent in low-altitude areas (<1999 m ASL) because 88.61% of all the quadrants sampled had been invaded. This included the areas between Naivasha town and Nakuru town. Conversely, only 6 out of 17 quadrats that occurred in areas above 2000 m ASL had been invaded by parthenium weed, representing 35.29%. These results were confirmed by a highly significant negative correlation between the occurrence of parthenium weed and elevation ($r = -0.507$, $p < 0.001$). This means that the occurrence of parthenium weed decreased as the elevation increased (Table 1).

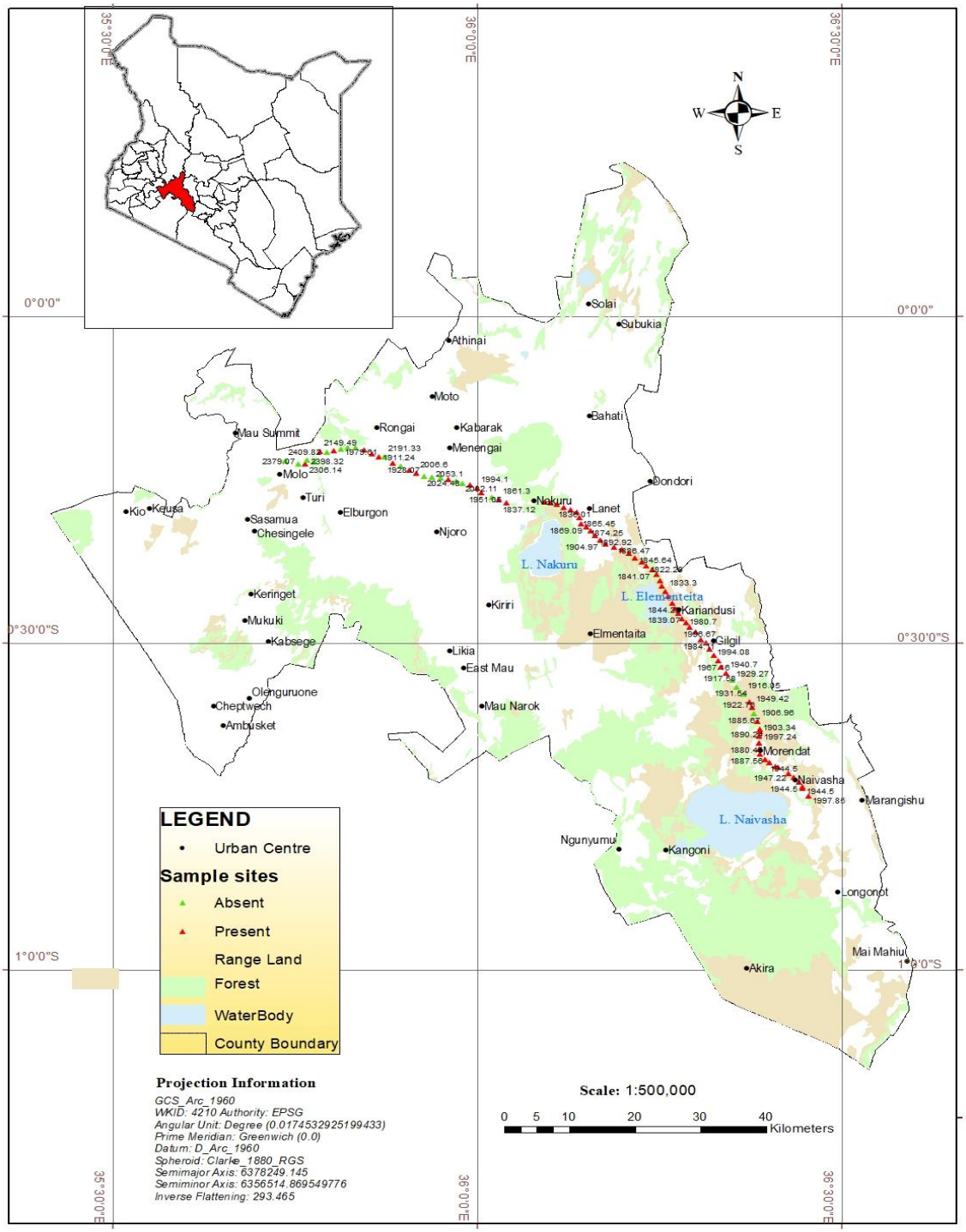


**Figure 3: *Parthenium hysterophorus* Distribution Map of the Study Area**

**Table 1: Effect of Altitude on the Invasion of Parthenium Weed**

| | | Occurrence | Elevation |
|---|---|---|---|
| **Occurrence** | Pearson Correlation | 1 | -.507** |
| | Sig. (2-tailed) | | <.001 |
| | N | 96 | 96 |

| | | | |
|---|---|---|---|
| **Elevation** | Pearson Correlation | -.507** | 1 |
| | Sig. (2-tailed) | <.001 | |
| | N | 96 | 96 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | |

Field observations revealed that parthenium weed was prevalent in disturbed areas such as those emanating from road construction works and the laying of telecommunication cables, drainage lines and dumpsites (Figure 4).

**Figure 4: Disturbed area paving the Way for Parthenium Weed Invasion**

*Note: Soil disturbance during the laying of telecommunication cable near the Mbaruk shopping centre along the Nairobi- Naivasha road opened the roadside for parthenium weed establishment (Mutua, 2021).*

Parthenium weed was also identified growing together with tree seedlings sold along the highway, serving as a seed dispersal channel across the country (Figure 5).

**Figure 5: Parthenium Weed Growing with Tree Seedlings**

*Note: Potted rose flower seedling growing together with parthenium weed near Kariandusi, Gilgil (Mutua, 2021).*

This study revealed that parthenium weed was widespread in Nakuru County, with 79.2% of quadrats sampled invaded. These results are in line with those by McConnachie et al. (2011), who reported that Kenya is climatologically favourable for parthenium weed invasions. This study revealed that parthenium weed was more prevalent in areas with low altitudes, such as Gilgil Sub-county ( Kikopey), where the majority of the quadrats sampled were invaded ($r = -0.507$, $p < 0.001$). These findings are congruent with those of the research by Dogra et al. (2011), who reported that parthenium weed was significantly (48.25%) more abundant between 300 and 1500 m ASL altitudes in the lower Himalayas as compared to the altitude ranging between 1500 and 2400 m ASL in the middle Himalaya. In another study conducted in Tanzania, Ojija and Manyanza (2021) reported that higher densities of parthenium weed were observed in lower altitudes. The habitat associations of parthenium weed in Mexico showed that almost 90% of occurrences were at elevations below 1500m ASL (CONABIO, 2015a in Adkins et al., 2018).

In Nakuru County, high-altitude areas, especially those between Rongai (Salgaa) and Molo (Kibunja) sub-counties, were characterised by minimal soil disturbance with high vegetation cover majority being Kikuyu grass (*Pennisetum clandestinum*) out-competed parthenium weed, thereby inhibiting its establishment. This study's results align with those by Ojija and Manyanza (2021) that parthenium weed was denser in disturbed habitats. Their study reported that high densities of parthenium weed were observed in landfills, dumping grounds, road drainage lines, and road edges. According to Strathie and McConnachie (2018), disturbed areas such as roadsides, railway tracts, stockyards, buildings and fallow agricultural land are particularly suitable for parthenium weed due to a lack of interspecies competition. This explains the abundance of parthenium weed in recently upgraded Kenyan roads, as observed in the current study and the studies by Abuto et al. (2018) and Wabuyele et al. (2014).

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

**Conclusions**: This study's findings found that the majority (79.2%) of the locations sampled had been invaded by parthenium weed. This invasion was concentrated along the roadsides, with a few plants sighted off the road demarcation. This invasion is likely to spread further unless urgent management measures are put into place. Parthenium weed is a highly prolific plant that easily spreads through water, wind, vehicle movement and soil-moving machines. With the projected increase in trade and movement of people following the elevation of Nakuru town to a city, parthenium weed is likely to spread far and wide. Further, this study established that the majority of the invasions were reported in low altitudes areas such as Naivasha and Gilgil sub-counties. These areas were synonymous with high soil disturbances and low vegetation cover associated with overgrazing by the Maasai, especially during the dry seasons. These open grounds form a conducive environment for the germination and growth of parthenium weed, which later serves as a seed reservoir for redistribution to uninvaded areas. It was further noted that roadside flower and tree seedling vendors were unprecedented dispersal channels of parthenium weed beyond the county's boundaries as the weed was found growing among their merchandise.

**Recommendations:** This study recommends that; the management of parthenium weed should start immediately since vast areas of Nakuru County are already invaded. The areas along the roadsides between Naivasha town and Nakuru city where high densities of the weed were identified should be given special attention. Studies have shown that the road transport network is a leading channel through which the weed is dispersed, and therefore more research on the mapping of parthenium weed on other road networks is required for the entire county. Furthermore, mapping should be done along waterways as parthenium weed is also spread by water flow. In addition, vegetation cover should be maintained since parthenium weed is an opportunistic invader that prefers areas where the soil has been disturbed, e.g. overgrazing, road construction and laying of underground telecommunication network cables.

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