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Distribution and Abundance of Parthenium (Parthenium hysterophorus L.) in East Shewa and West Arsi Zones of Ethiopia

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Abstract
Parthenium hysterophorus L. is a herbaceous invasive alien weed belongs to the family Asteraceae now recognized as the major emerging problems and pose the greatest threats to native species and ecosystems in Ethiopia. This non-native species, subsequently escaping from their entry points and are spreading at an alarming rate from time to time. Precise distribution of the existing *Parthenium hysterophorus* is poorly understood and systematically documented. Thus the aim of this study was to generate information for a better understanding of the distribution and abundance of *Parthenium hysterophorus* in East shewa and West arsi Zones of the Oromia regional governmental state of Ethiopia. The biological data were collected along gravel and asphalt roads at interval of 10km. Relative abundance and distribution were determined. The locations' latitude and longitude coordinates were recorded with a garmin GPS in order to map their abundance and distribution using arcGIS 9.1 software. The study revealed that *P. hysterophorus* extensively distributed in study area mainly in East shewa zone where it infest most of terrestrial habitats (Road side, Farm land, Pastoral, around habitation Waste land) and it has a potential to flood all districts not infested currently in the study area. Moreover, *P. hysterophorus* hinders economic development of the study area and the country at large. Therefore, proper and targeted control methods should be employed to control the further spread of invader and reduce the negative economic impact. Thus proper management action should be taken to mitigate their impact.
Keywords: abundance, distribution, distribution map, *Parthenium hysterophorus*

1. INTRODUCTION

Parthenium *(Parthenium hysterophorus* L.) belongs to the family Asteraceae, an extremely diverse family with a cosmopolitan distribution *which is* invasive alien weed. It has been further classified under the tribe Heliantheae and subtribe Ambrosiinae. It is described as an annual, procumbent, diffused leafy herb with a height of 0.5 - 1.50 m, reaching a maximum of 2 m in good soils (Parsons and Cutherbertson, 1992).

From its centre of origin, parthenium had spread to Africa, Australia and Asia during the last five decades (Aneja *et al.,* 1994). Now it has been widely distributed in South and East Africa. As elsewhere in the world (Evans, 1997), parthenium, an alien invasive weed has been threatening the natural and agricultural ecosystems in Ethiopia. *P. hysterophorus* was regarded to be introduced accidentally through aid shipments or from Somalia during Ethio-Somali war in 1976/77(Besufekad *et al.,* 2005, Taye 2002). Its invasion expanded at alarming rate in all directions mainly following slope gradient. Even though, there are different factors that favor fast distribution of the weed, flooding and movement of vehicles are the major factors. This radiation occurs particularly in the direction of low slope and waterways (Adane, 2008).

P. hysterophorus clearly poses a major threat to rangelands, croplands and cause health problems of animals and human. Overall impact on crop production system is multifaceted, both direct and indirect by affecting grazing land, animal health, milk and meat quality, and marketing of pasture seeds and grains. The main impact of parthenium on crops relates to its allelopathic properties. The chemicals which it produces significantly inhibit the germination and subsequent growth of a range of crop plants (Navie *et al*., 1996; Evans, 1997). Jayachandra (1971) stated that the parthenium can be a serious problem in grasslands in and can reduce the pasture carrying capacity by up to 90%. Belachew K and Tessema T (2015) stated that diversity and evenness of species declined with increasing spread of parthenium which suggests negative influence that parthenium had on the status of species diversity. It is also known to cause human health problems like asthma, bronchitis, dermatitis, and hay fever (Kololgi *et al*., 1997; Srirama Rao *et al*., 1991). Evans (1997) and Towers and Subba Rao (1992) also reported that close contact with *P. hysterophorus* could cause allergic contact dermatitis while inhalation of pollen can cause allergic rhinitis, which can develop into bronchitis or asthma in susceptible humans.

Even though parthenium is causing severe damage, on crop production, animal husbandry, and biodiversity in Ethiopia, there is no much documented information about its abundance and distribution, and not mapped to show its abundance and distribution. Therefore, More accurate knowledge of the distribution and relative abundance of parthenium infestations will allow the application and maximization of the efficacy for its management by prioritizing areas for early control measures and thus limiting spread of the weed. Besides,

mapping the extent of invasive alien plant species infestation, contributes towards planning area-wide management of the weed. However, there is no adequate information available with regard to the abundance and distribution of parthenium in East Shewa and West Arsi zones of Ethiopia. Hence, this study is initiated with the following objectives.

a. To determine the distribution and abundance of P. *hysterophorus* L. at East Shewa and West Arsi zones of Ethiopia and

b. To develop distribution map of P. *hysterophorus* L. in the study areas.

2. MATERIALS and METHODS

2.1. Description of the Study area

The study were West Arsi and East Shewa Zones at Oromia Regional State of Ethiopia. The area is located in the middle of Oromia region, connecting the western regions to the eastern ones. These zone are bordered on the south and southwest by the Southern Nations, Nationalities and Peoples Region, on the west by West Shewa, on the northwest by North Shewa zone Ormia regional state and the Amhara Regional state, on the northeast by the Afar Regional state, and on the southwest by Arsi Zone. This area is part of East African Great Rift Valley that stretches from Damascus, Syria to the north upto Mozambique and to the South of Africa. The altitudinal range of the area is between 950 – 2590 m.a.s.l with hilly steep escarpment rising to an elevation of 3000 m.a.s.l. The area is described as an agricultural field of mostly low level plain and some mountain escarpments (Anonymous, 1997). The climate of the area is semi-arid type. The highest mean monthly rainfall has been recorded between July and September. The amount of rainfall gradually increases from March to May and sharply falls from October to December. The highest rainfall was recorded in August (220 mm) and lowest in December (4.5 mm), whereas an average total annual rainfall of 850 mm during two rainy seasons. The highest mean monthly temperature has been recorded in June (23.3^0c) and the lowest annual mean temperature is 18.9^0c (Debela *et al.,* 2004; Belachew K and Tessema T, 2015).

2.2. Survey on the distribution and abundance of P. hysterophorus L.

Survey of *Parthenium hysterophorus* L. was conducted in East Shewa and West Arsi zones from October to February 2012/13. Visual observation on distribution and spread of the weed was noticed at different districts of the zones at regular intervals of 10 Km. Distribution and abundance of *P. hysterophorus* was recorded at different infested habitats (natural/semi-natural, and disturbed/man made habitats). Due to immensity of the study area it is difficult to count each species. Thus abundance was determined by using abundance scale (Table 1) after the modification of the methods used by Martin and Foxcroft (2002) and estimation scale (Wittenberg *et al*., 2004).

Up to date data on the distribution and spread of *P. hysterophorus* in the East Shewa and West Arsi zones was developed. This was followed by the development of a GIS system for mapping extent of weed infestation for planning area-wide management of invasive alien plant species.

2.3. Development of existing and potential distribution maps

Observation was made at interval of 10Km which are easily accessible by car. The locations' latitude and longitude coordinates of the parthenium infested areas were collected and recorded using a handheld GPS and simultaneously the presence/absence and abundance was determined and recorded on data collection sheet. The data collected from the field, district boundary, towns and roads layers imported in to ArcGIS 9.1 software, to develop point distribution map and abundance map of the study area. Thus the field data collected from peasant association (village) level were aggregated to district level and from this data abundance map generated at district and zone level. At last point distribution map showing presence or absence and abundance map of *P. hysterophorus* L. was developed.

Table 1. Level of abundance and Cover percent.

No	Level of abundance	Character	Cover percent
1	Very abundant	When the area within 400m radius was covered by extensive stand	>90
2	Abundant	When the area within 400m radius was covered by many clumps	80-89
3	Frequent	When the area within 400m radius was covered by many sightings of single plants or small groups	60-79
4	Occasional	When the area within 400m radius was covered by a few sightings of one or a few plants	45-59
5	Rare	When the area within 400m radius was covered by one or a few plants	20-44
6	Present	When the area within 400m radius was abundant uncertain	1-19
7	Absent	No *P. hysterophorus* found	0

2.4. Data Analysis

The biological data obtained from the field were analyzed using Ms-Excel, and ArcGIS 9.1 software.

3. RESULTS AND DISCUSSION

3.1 Distribution and spread of Parthenium (Parthenium hysterophorus L.) in East Shewa and West Arsi Zones.

Parthenium is one of the major plant invader dominant weed in study area and known with various vernacular names with local community to express its importance. These include: *Feremsisa, Biyakasa, Biyabassa, and Aliwariyo*. The names imply its impact and invasiveness on their livelihood. "*Biyabassa*" or "*Biyakasa*" means cause to leave the region due to its negative effect; "*Faramsisa*" means cause to sign to leave the property (grazing land, farm land and animals) for it or it means force to sign to receive donated grain and "*Aliwariyo*" means fast moving serious weed.

Thus biological invasion by *P. hysterophorus* is one of the emerging problems of the study area and Ethiopia at large which threat to biodiversity and ecosystem services, and also have significant social, ecological and economical impacts (Belachew K and Tessema T, 2015). The survey made in East Shewa and West Arsi indicated that Parthenium was highly distributed in many surveyed locations. It was observed at different altitudes ranging from 959-2582m.a.s.l in the study area and infest different habitats, i.e. agricultural lands, range lands, national park, water ways, bank of rivers, roadsides, urban green spaces, grasslands, bush lands and forestlands, crop fields and field borders and urban settings. East Shewa zone is more seriously invaded zone than West Arsi being a place where high investment activities are carried out. This zone is becoming a source of infestation of parthenium. According to key informants in the study area Parthenium was introduced to the area few years ago and at a time it was commonly found in roadside, railway embankments but then invades crop lands, grass land and overgrazed land in alarming rate.

The study revealed that Parthenium is widely distributed in East Shewa and is spreading in alarming rates to West Arsi districts following main road from Modjo town to Awassa town (Figure 1). Level of infestation of Parthenium varied among different districts of the zones. High infestation was observed at *Fentale, Boset, Adama, Lume, Adaha, Akaki, Dugda, Bora, Adamitulu, Jidokonbolcha, Ginbichu, Libanchukala, Arsinegele* and *Shashamne* districts. However, the non-infested districts were, *Siraro, Shalla, Kofale, Kore, Dodola* and *Gedebasasa*.

At Fentale district parthenium grows even in arid locations and rocky sites dominated by volcanic ashes at elevation below 1000 m. According to Hedberg *et al*., (2004) parthenium weed can grow at altitude of 900-1800 m a.s.l. More over in this study it can grow up to 2500 m.a.s.l. These indicate that the species has wider ecological amplitude and adaptability.

In *Boset* and *Adama* districts very wide and intensive infestation of Parthenium was observed on road sides, crop land, grazing land, villages, and waste land. On the main high way from *Adama* to *Boset* districts infestation vary from field to field depending on the kind and frequency of control action taken by farmers, crop types and number of other weeds which compete with Parthenium.

In *Lume* and *Adea* districts high population stands of parthenium recorded mainly on the roadside, around habitation, green spaces and agricultural lands mainly during the off season period. Very extensive stands of the weed was also observed around the fenced industrial areas of the two districts indicating that parthenium population is high in place where soils are disturbed constantly for the purpose of construction . Spread parthenium was also observed from *Adea* to *Ginbichu* and *Liban* districts following routine disturbance and upgrading of gravel roads ridges (Figure 1).

It was noticed that irrigation lands around *Koka* and near *Batu* lakes were severely affected by dense population of parthenium. Level of infestation decrease and limited to roadside and around urban open spaces on the main high way From Batu to Shashamane indicating that Parthenium is spreading to wards west Arsi and has a potential to invade non infested districts unless control options made.

Figure 1. **A**-Parthenium spreading to Ginbichu at road sides; **B**-Maize land infested with Parthenium (Woelchiti); **C**-infestation of Parthenium on grazing land (Lume); **D**-Infestation of Parthenium on irrigated land (Koka).

3.2 Distribution of P. hysterophorus in relation to habitats

Parthenium weed invaded a wide range of environmental habitats of the study areas. The field survey made indicated that Parthenium infestation is very high and the most serious in disturbed habitats. Road side, around habitation and grazing land are the three highly infested habitats where soil disturbance is favorable for its colonization (Figure 2). High abundance along roadsides in the different districts was attributed to continuous disturbance and transportation of sands and soil for construction and maintenance of roads. Transportation of construction materials like soils, sands, gravel stones and others, movements of animals, transport vehicles and heavy machineries and other activities around habitation also contributes for wide-ranging of invasions of parthenium. Taye (2002) reported that the extensive dense stands along roadsides in Ethiopia might be due to the routine disturbance and upgrading of road verges.

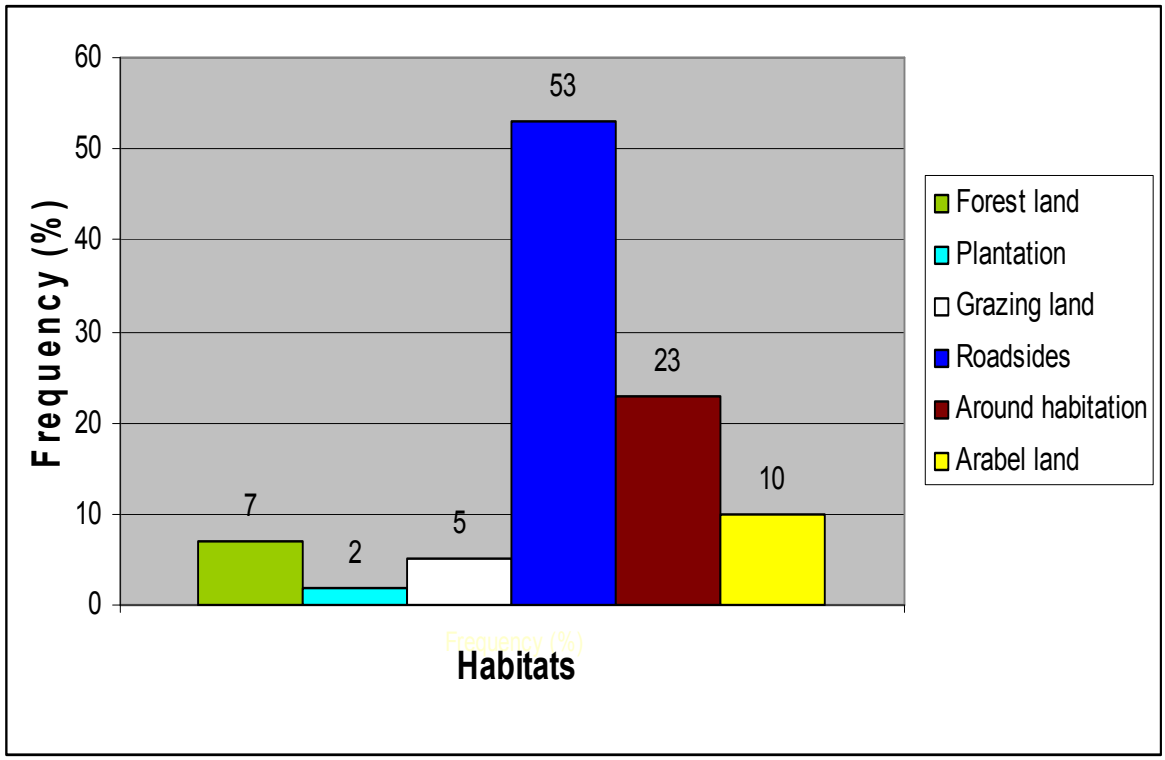

Figure 2. Distribution of parthenium in different habitats.

3.3. Abundance and distribution maps of P. hysterophorus

Parthenium was widely distributed in the study area. Indeed, the invasion of the weed begun few years ago but it expanded at alarming rate in all directions. The invasion first seen on road side and radiated to different habitats. The harms of the weed on crop production, livestock production, biodiversity and human health continue unless proper action has been taken. Thus weeds maps are useful for recognizing the affected area and potential distribution of the weeds, and for preparing of a management plan. These maps are also valuable for researchers, decision makers and different stakeholders.

The noxious weed *P. hysterophorus* expanded in horrible rate to almost all districts of East Shewa and some districts of West Arsi (Figure 4) and the weed is strong enough to cover almost all entire habitats in study area.

As figure 3 below depicts *P. hysterophorus* was highly abundant at Boset and Akaki Districts. Early introduction and plane slope at Boset resulted in wide expansion to different habitats. High investment activities and transportation of soils for construction from place to place might have resulted in high infestation of *P .hysterophorus* at Hakaki. The next highest abundance occurred at *Adama, Lome, Adea, Bora, Dugda, Fentale, Adamitulu* and *Arsi negele*. Parhenium also present with lowest abundance at *Ginbichu, Liben, Siraro*, and *Shashamane*.

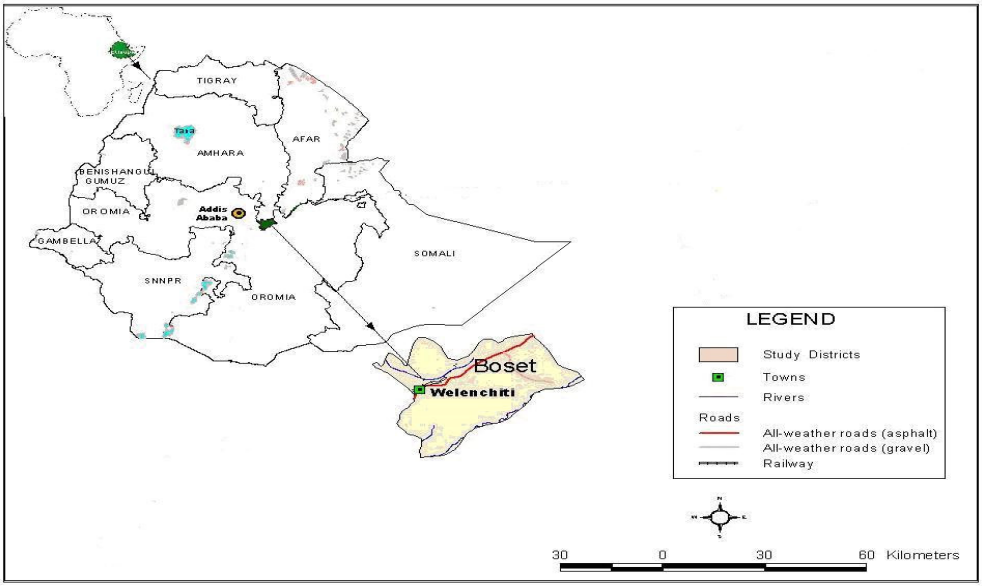

Figure 3. Study area location relative to Ethiopian map.

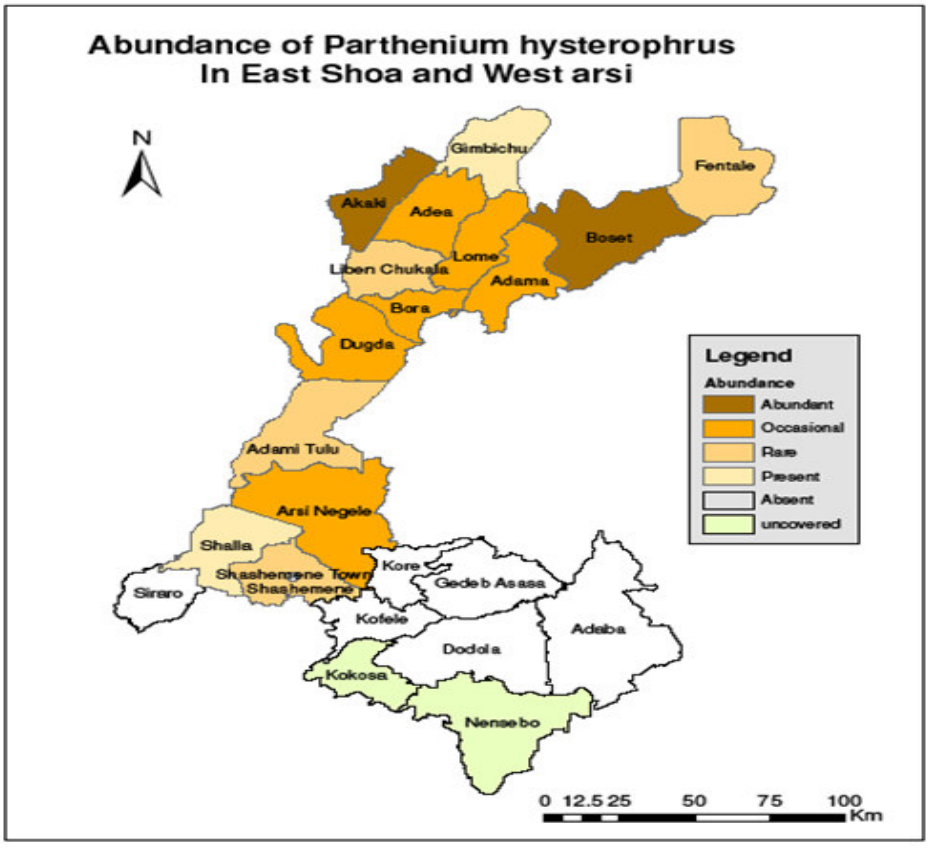

Figure 4. Mean abundance of parthenium weed in East Shewa and West Arsi zones, Oromia Regional State

4. CONCLUSION

Parthenium *(P. hysterophorus* L.*)* was became the major problems of study area especially in East shewa zone which local dwellers can not shoulder. The problems still continue due to fast dissemination of the weed and lack of proper management options to keep the weed below economic damaging level. Parthenium invaded farmlands, Roadsides, grazing lands, wastelands, in towns and villages and gardens. In this study distribution and abundance of parthenium had been documented, in addition to this distribution and abundance maps were developed using sophisticated technologies (GPS and GIS). These help to provide information to allow area-wide management of parthenium weed.

P. hysterophorus extensively distributed in study area mainly in East shewa zone where it infest most of

terrestrial habitats (Road side, Farm land, Pastoral, around habitation Waste land) and it has a potential to flood all districts not infested currently in the study area.

Thus *P. hysterophorus* hinders economic development of the study area and country at large. Therefore, proper and targeted control methods should be employed to control the further spread of invader and reduce the negative economic impact.

The following recommendations are given in order to mitigate the weed in study area and country at large.

1. Risk assessment should be done for plant species to know the overall social and environmental impact of the plants and its rate of expansion.
2. Quarantine measures should be adopted to prevent the introduction of the weed from infested to non-infested area.
3. Farmers, pastoralists and agro-pastoralist should be trained by responsible governmental and nongovernmental organization on the biology and management of the weed.
4. Integrated management system should be employed by combining different Management options for effective control the Weed.

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