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Distribution and Socio-economic Impacts of Prosopis juliflora in East Shewa and West Arsi Zones, Ethiopia

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Abstract
Prosopis juliflora is exotic species which have been thought to be introduced to Ethiopia as agroforestry. Nowadays it is notorious and emerging problems to animals, native plant species and ecosystems in the country. Precise distribution and socio-economic impacts of the weed is not predictable in the study area. Thus the aim of this study was to generate information for a better understanding of the distribution and socio-economic impact of *Prosopis juliflora* in East shewa and West arsi Zones of the Oromia regional state. 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. To meet information about socio-economic impacts towards Prosopis, data were collected through semi-structured questionnaires. The study revealed that *P. juliflora* was observed at Fentale, Boset, and Adama districts of East shewa zone with different infestation level. However, no infestation observed in West arsi zone. Relatively high infestation level was recorded at Fentale due to regular movement of pastoralist around the district to search grass for their animals. Distribution maps showing presence or absence and abundance of Prosopis were developed. The study also revealed that *P. julflora* mainly spreads through animals' dung. 90% of respondents in high infestation area stated that the important dispersal agents were mainly cattle, camels, sheep, goats and wild animals. According to 98% of respondents grass species are disappearing from highly infested area. This indicated that P. julflora is suppressing the growth of grasses under its canopy. Fifty percent of respondents in high infestation and 28% of respondents in less infested area also indicated that Prosopis encroaches grazing land, cause scarcity of animal food and forms impenetrable thickets and strong thorns which prevent free movement of livestock in searching of food and causing wounds on their skins. *P. juliflora* also affect human health in different ways as noted by respondents. Generally P. juliflora has significant impacts on crop production, livestock production, biodiversity and human and animal health.
Keywords: *Prosopis juliflora*, distribution, distribution map, socio-economic

1. INRODUCTION

Prosopis juliflora (Swarz) DC is a perennial thorny deciduous shrub or a small tree weed belonging to the family Leguminose. It was described in Ethiopia by different authors as large crowned evergreen tree with a deep taproot and a well-developed lateral root system; height ranges between 1-18 meters, depending on the type of soil in arid and semi-arid conditions; armed with stout yellowish nearly straight poisonous spines arising in pairs (Kassahun, 1999; Hailu *et al*., 2004; Kassahun *et al*., 2004).

P. juliflora is exotic species which have been introduced in most tropical and sub-tropical countries including Ethiopia. The plant has been cultivated for shade, timber, forage, food, and firewood. However, contrary to its purpose of introduction, the plant escaped out of control and has invading farm lands, pastures lands, rang lands and irrigation schemes (Rezene, 2006).

Since 1980s this plant has spread rapidly in eastern Ethiopia, from the Middle Awash Valley in to the Upper Awash Valley and Eastern Hararghe and some localities of Raya Azebo plains of South Tigray. The invasion has also reported in the town of ArbaMinch and neighboring localities in South region of the country (Rezene, 2006). The edible nature of the pods and prosopis seed dispersal mechanisms by cattle, sheep, goats and wild animals and coppicing nature of the plant after stumping are some of the characteristics that facilitate its invasion (Hailu et al., 2004).

Prosopis clearly poses a major threat to rangelands, croplands and cause health problems of animals and human. It causes the overall loss of natural pasture, displacing of native trees, reduction in stocking rate, toxicity to livestock, formation of impenetrable thickets and increased incidence of crop pests (Senayit *et al*., 2004;Taye *et al*., 2004). Invasion of prosopis rangelands caused shortage of grazing land for livestock, which resulted in drastic reduction of livestock number as well as products (Senayit *et al*., 2004). This is mainly due to reduced land carrying capacity as prosopis trees are displacing desirable grasses that could not withstand the aggressive competition for light, nutrient and moisture (Taye *et al*., 2004). Although the seed podsof prsopis are indeed palatable to livestock, the chemical content is thought to cause problems for goats, cattle, camel. A diet high in pods can cause mortality in sheep and goats due to digestive problems like impaction. Cattle can die if they feed heavily on *P. juliflora* leaves over a prolonged period of time owing to its tannin contents (Mwangi and Swallow, 2005). Senayit *et al*., (2004) also reported that thorns damage eyes and hooves of camels, donkeys, and cattle with poisons eventually leading to death of animals.

Prosopis also has an effect on human health. The most important effect of prosopis on human health is that its thorns cause itching and bring tetanus. Its thorns can even cause blindness (Senayit *et al*., 2004). Prosopis causing problems to cattle breeders, because camel consumption of leaves lead to their sickness, eating their solid seed pods may result in falling out cattle teeth and reduction of their ability to graze. Some local people in Ethiopia believe that consumption of *Prosopis* leaves by camels causes flatulence, diarrhea and some times constipation and thorns of prosopis are harmful to human beings and livestock (Abdillahi *et al*., 2005). Eventhough *Prosopis juliflora* has negetive impact on biodiversity,animals and human being its distribution and socio-economic impacts not documented in the study area. Thus this study aims to assess distribution and socio-ecnomic impacts of *P.juliflora* in East shewa and and West arsi zones of Oromia regional state,Ethiopia.

2. MATERIALS AND METHODS

2.1. Description of the Study area

The study was conducted in 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 zones 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 of Oromia 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 up to Mozambique and to the South 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 (23.30c) and the lowest annual mean temperature is 18.90c (Debela *et al.,* 2004; Belachew K and and Tessema T, 2015).

2.2. Survey on the distribution and spread of *P.juliflora*

A survey of prosopis was conducted in east shewa and west arsi from October to March 2010/11. Visual observation on distribution and spread of prosopis was recorded at different districts of the zones at regular intervals of 10Km. Distribution and abundance of the weed was recorded based on the level of infestation at different infested habitats. Abundance of each species 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 of prosopis in the East shewa and West arsi were recorded. This was followed by the development of a GIS system for mapping extent of the weed infestation.

2.3. Developing distribution Map

Observation was made at interval of 10Km which are easily accessible by car. The locations' latitude and longitude coordinates of prosopis was collected and recorded using a garmin GPS and simultaneously the presence/absence and abundance was recorded on data collection sheet. The data collected from the field, district boundary, towns and roads layers imported into ArcGIS 9.1 software, to develop point distribution map and abundance map of the study area. Thus the field data collected from the field at Kebele level aggregated to district level and from this data abundance map were generated at district and zone levels. At last point distribution map showing presence or absence and abundance map of major IAPS were developed.

Table 1. Abundance scale and coverage estimates used in Prosopis assessment (Martin and Foxcroft 2002)

No	Level of abundance	Descriptions	Cover percent
1	Very abundant	When the area was covered by extensive stand	81-100
2	Abundant	When the area was covered by many clumps	56-80
3	Frequent	When the area was covered by many sightings of single plants or small groups	31-55
4	Occasional	When the area was covered by a few sightings of one or a few plants	10-30
5	Rare	When the area covered by few plants	5-9
6	Present	When the coverage small and abundance uncertain in the area	1-4
7	Absent	No Prosopis found	0

2.4 Assessment of socio-economic impacts of *Prosopis juflora* in East shewa and West arsi zones

To congregate information about socio-economic impacts as well as the local people's perception towards Prosopis

in the study area, data were collected through sem-structured questionnaires. The questionnaires were provided to farmers, development agents (DAs) and experts.

Depending on the severity of the invasion and distribution of the weed in the zones, respondents in the districts were stratified into highly invaded, medium invaded and non-infested areas based on preliminary survey and group discussion conducted with the zonal agricultural experts to investigate the economic impacts of Prosopis under varying infestation. This approach allowed comparison of results from infested areas with areas not yet infested. The latter areas served as a 'control' and without control communities it would be difficult to determine the effect of the weed on the target group (Wittenberg, 2004). A total of 183 respondents among households, DA's and experts were selected using systematic sampling technique.

2.5 Techniques of Data Analysis

The data obtained from the field were imported to ArcGIS 9.1for mapping of invasive alien plant species distribution and abundance. The socioeconomic data were analyzed by using SPSS Version 16.0 software. The questionnaires were coded and the data entered in Computer for analysis.

3. RESULTS AND DISCUSSION

3.1 Abundance and distribution of *Prosopis juliflora*

The invasive evergreen plant species, *Prosopis juliflora* was thought to be introduced first to Afar regional state and spread to different parts of Ethiopia and the study area too. Vernacular name of *P. juliflora* in the study area is *'Muka Weyane*' referring its introduction and spread after EPRDF government came to emerge.

In East Shewa zone, *P. juliflora* was observed at Fentale, Boset, and Adama districts with different infestation level. However, no infestation observed in west arsi zone. High infestation were recorded at Fentale because of pastoralist movement from Afar National Regional State to the border areas of Fentale to search for grazing grasses for their animals and intentionally planted by inhabitants for shade to improve the warm climatic conditions (Figure 2). Rezene (2006) also indicated that Prosopis has been cultivated for shade, timber, forage, food, and firewood.

At Methara (District town) especially at Addis Ketama and surrounding areas *P. juliflora* was very abundant and form dense impenetrable barrier restricting the movement of people and it is spreading at alarming rate to neighboring localities (villages, grazinglands and farmlands).

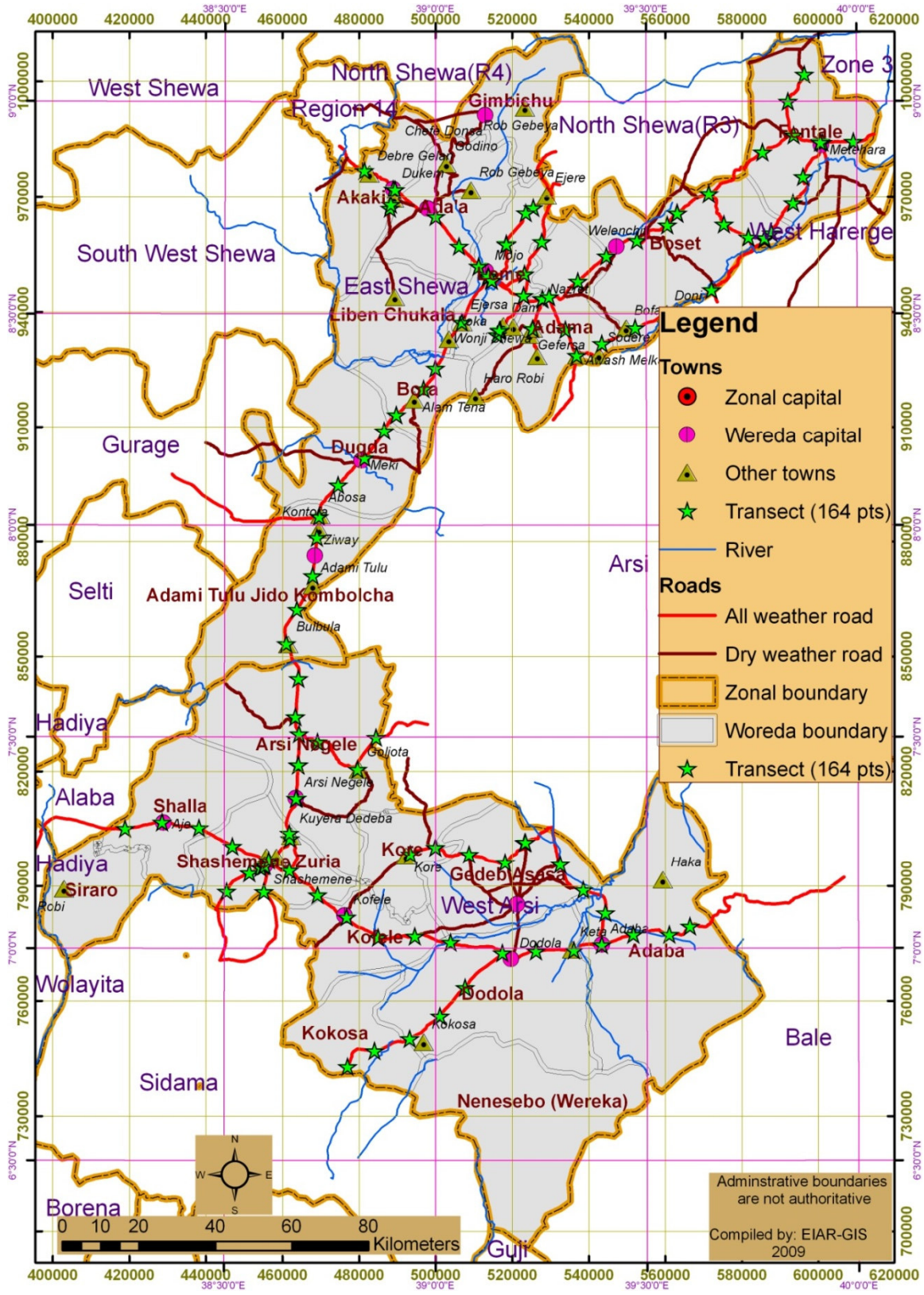

Figure 1. Map of East shewa and West arsi zones of Oromia Natonal Regional State.

Figure 2. *P. juliflora* around habitation used as shade at Awash Melkas town

High population stand of prosopis plants were also noted along roadside and decreased away from the roads proves that movement of livestock (being driven on the roadsides) disperse seeds of Prosopis through their dung. This observation was in agreement with Hailu *et al*., (2004) who reported that seed dissemination via livestock faeces (goat, cattle, camel, sheep, wild herbivores etc.) is a major means of its dispersal. In Fentale district *P. juliflora* is invading road sides, around habitation and grazing land.

Figure 3. *P. juliflora* along the main high way from Methara to Adama

Escape of heavy stands of prosopis was also observed in Metahara area and neighboring localites of Boset and Adama districts. Infestation level along the road is decreasing on main high-way from Fentale to Boset-Adama districts (Figure 3)

Figure 4 shows *P.juliflora* spreading at faster rate to neighboring localities of boset and adama districts owing to unrestricted movement of animals.

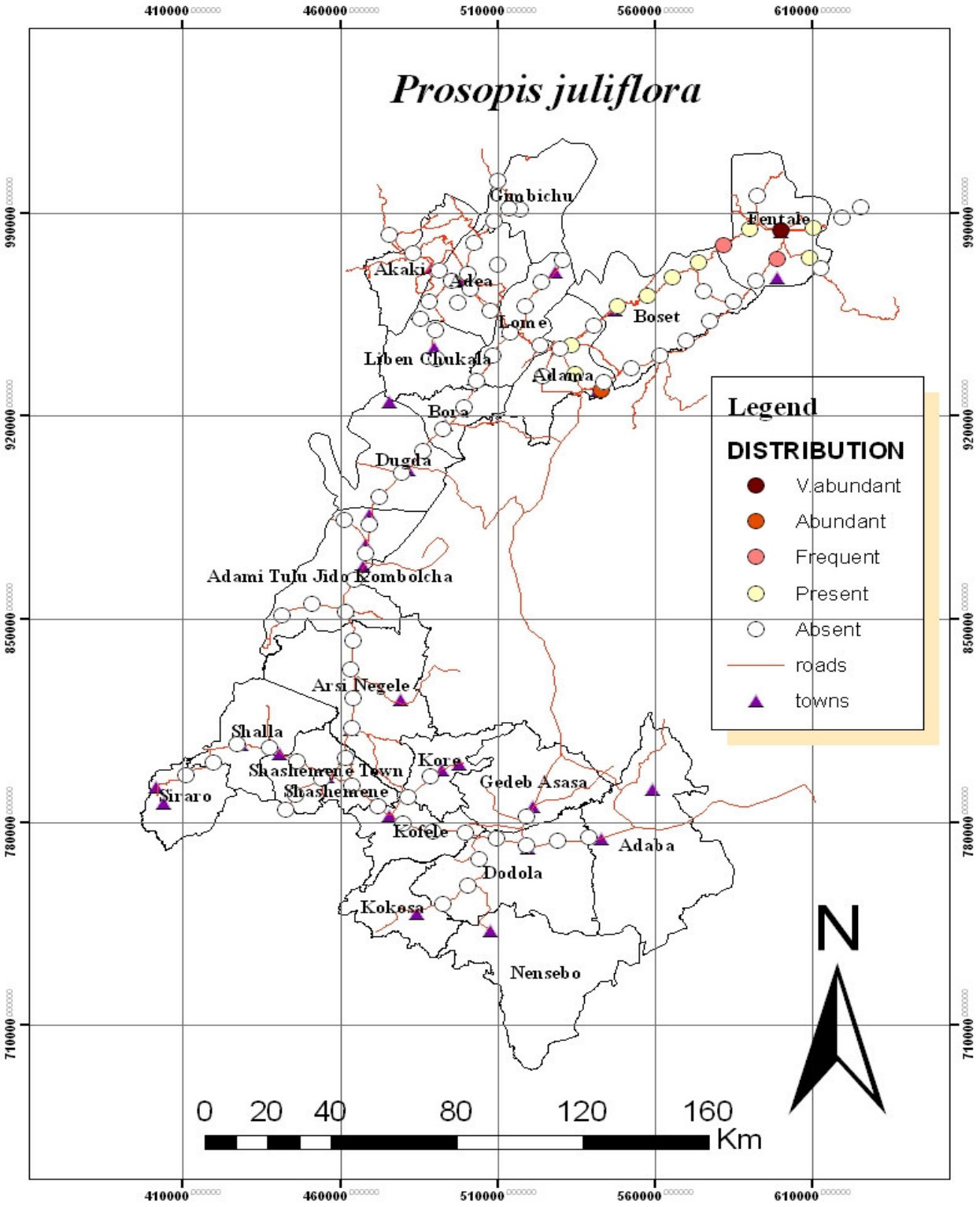

Figure 4. Distribution of *P. juliflora* in East Shewa and West Arsi Zones, Oromia National Regional State

Few young plants of prosopis were observed at Wonji and Awash Melkasa towns which were intentionally planted for shade (Figure 5).

Figure 5. *P. juliflora* deliberately planted at Matahra town.

In Adama district, around Sodare (Tourist attractive recreational area) were highly infested with *P. julifloroa.* Figure 3 indicted that high abundance of prosopis at Fentale followed by Boset and Adama districts.

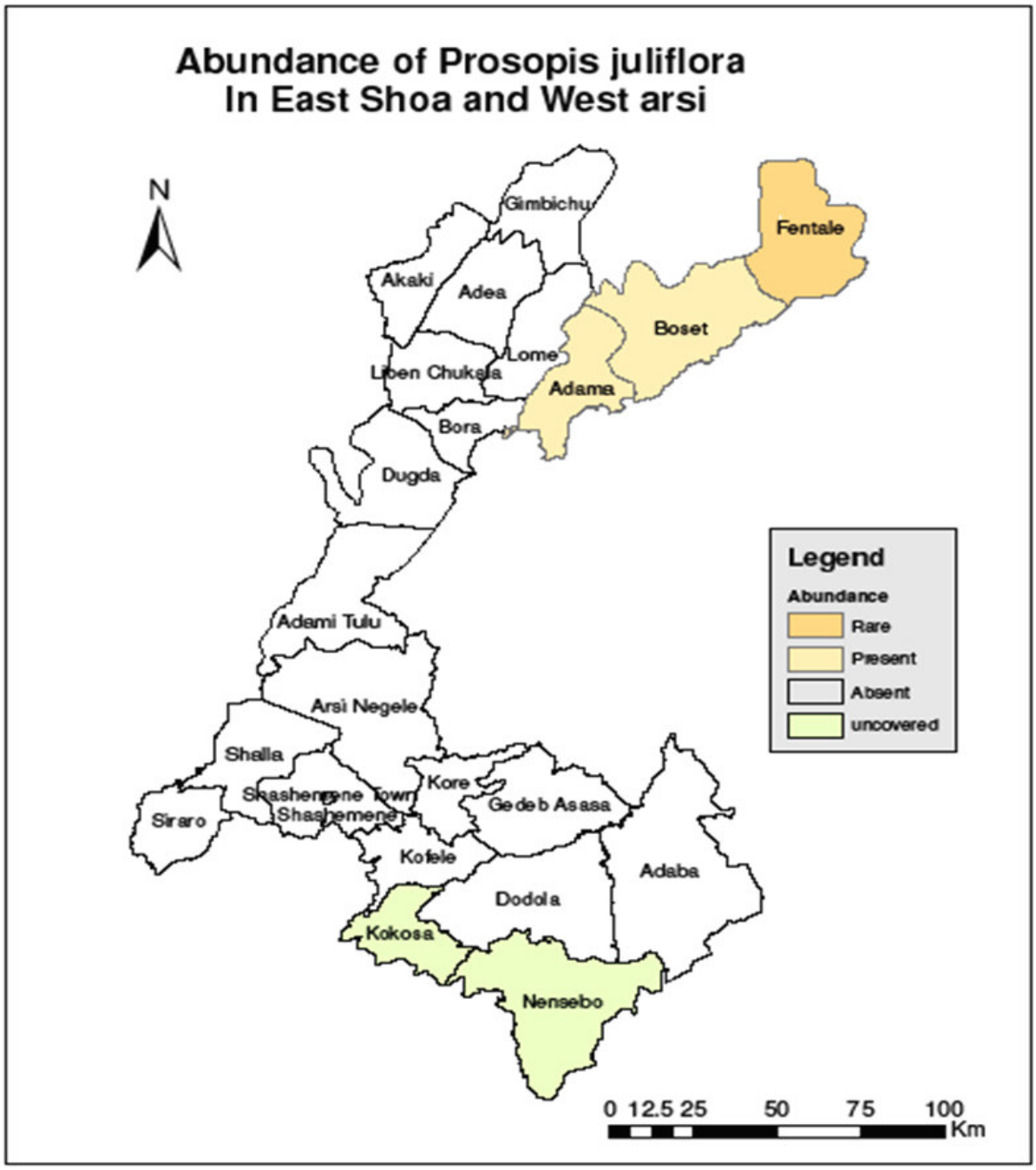

Figure 6. Mean bundance of *P. juliflora* in East Shewa and West Arsi Zones, Oromia National Regional State

2.1.1 Distribution of Prosopis in different habitats

P. juliflora, readily adapts to supreme environmental conditions. The study revealed that Prosopis invades roadsides, around habitation, plantations, forests and pasture land. However infestation aggravated in roadsids and around free space of urban. This is because of movement of animals driven along the roads to market or to search grazing for their animals and deliberately planted for shades and fence around habitation. The weed is also expanding to pastoral lands and natural forests of Awash national park (Figure 7).

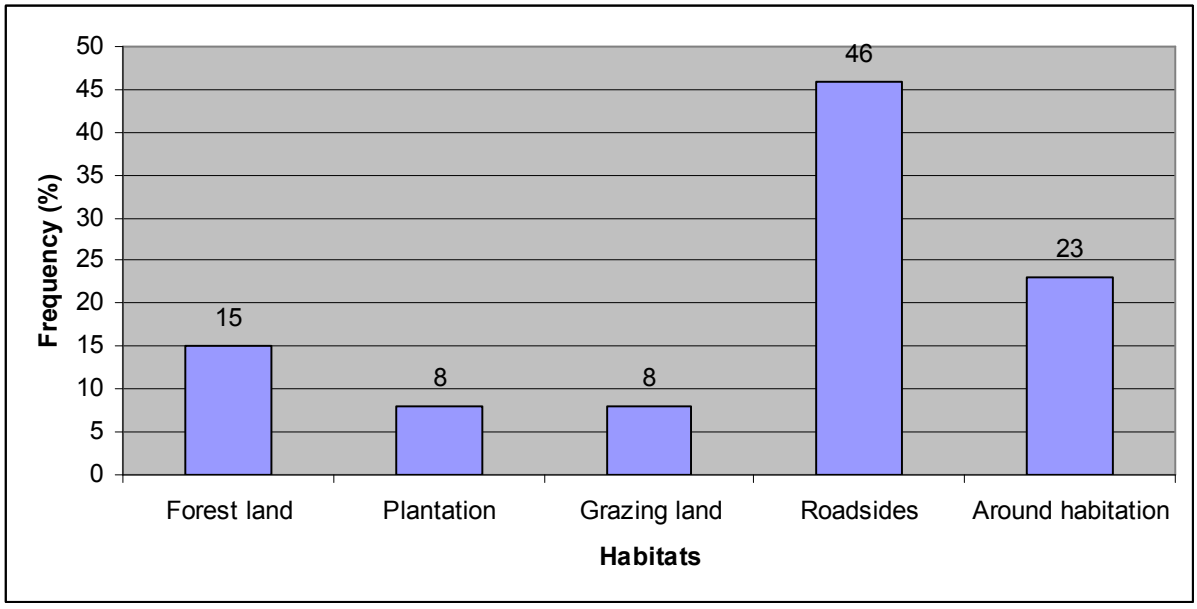

Figure 7. Distribution of prosopis in different habitats

3.2 Socio-economic impact of *Prosopis julflora*

In highly invaded areas, respondents noted that *P. julflora* caused various problems includes: decrease rangelands, health impacts on animals, narrowing of ways among villages, piercing of skins of animals and forming thick thorns which prevent movement of animals.

3.2.1 Respondents' perception on means and sources of introduction of P. *juliflora*

The study revealed that different respondents have different view about from where the species was introduced to the study area. Generally about 68% of the respondents in high infestation and 63% of respondents in less infestation category stated that the plant was first introduced to Fentale district from Afar National Regional State. Twenty-three percent of respondents in high infestation and 13% in less infestation area reported that *P. julflora* introduced to area from nursery which deliberately planted to improve the harsh environmental conditions. As 12 and 21% of respondents the weed was introduced by Merchants of animals and from near districts of respectively (Table 2).

Table 2. Respondents' perception on source of introduction of *P. julflora* in East Shewa and West Arsi Zones, ONRGS

Source of introduction	High infestation N=40		Less infestation N=40		No infestation N=40		Total	
	n	%	n	%n	%	n	%	
Afar	27	68	25	63	0	0	52	43
Nursery	9	23	5	13	0	0	14	12
Merchants	13	33	0	0	1 3	14	12	
Near district	0	0	25	63	0	0	25	21

N= sample size of each category n= Frequency

Interviewed respondents in high infestation (90%) and in less infested area (70%) discovered that *P. julflora* mainly spreads through animals dung (Table 3). The most important dispersal agent of *P. julflora* is animals mainly cattle, camels, sheep, goats and wild animals. The animals feed the pod of the weed and release the feces contain seeds of *P. julflora* in which seed coat semi digested that makes easily dispersed and germinate. This also reported by Hailu et al. (2004) which stated that the edible nature of the pods and its seed dispersal mechanisms by cattle, sheep, goats and wild animals and coppicing nature of the plant after stumping are some of the characteristics that facilitate its invasion.

Table 3. Respondents perception on agents facilitate dispersal of *P. julflora* in East Shewa and West Arsi Zones, ONRGS

Means of Dispersal	High infestation N=40		Less infestation N=40		No infestation N=40		Total	
	n	%	n	%	n	%	n	%
Livestock dung	36	90	28	70	21	53	85	71
Flood	9	23	11	28	5	13	25	21
Wind	12	30	13	33	0	0	25	21

N= sample size of each category n= Frequency

3.2.2 Respondents' perception on impact of *Prosopis juliflora* on biodiversity

According to 98% of respondents grass species are disappearing from highly infested area when compared with less infected area. This indicated that *P. julflora* is suppressing the growth of grasses under its canopy and the biodiversity by computing both resources and natural environment. This is in line with Taye (2004) report who stated that prosopis trees are displacing desirable grasses that could not withstand the aggressive competition for light, nutrient and moisture. The impact is not significant because the plant recently introduced and not entirely covered the areas.

3.2.3 Respondents' perception on impact of *P. julflora on* crop production, livestock production and human health

Of the respondents in high infestation area 68% elucidated that the plant decreases the size of farm and roots of *P. juliflora* makes difficult to plough lands. Fifty percent of respondents in high infestation and 28% of respondents in less infested area became aware about effect of *P. juliflora* on livestock production and health. It encroaches grazing land and cause scarcity of animal food. They also perceived that plant forms impenetrable thickets and strong thorns which prevent free movement livestock in searching of food and causing wounds on their skins. Senayit et al (2004) also reported that thorns damage eyes and hooves of camels, donkeys, and cattle with poisons eventually leading to death of animals.

P. juliflora also affect human health in different ways as noted by respondents. Seventy percent of interviewed individuals in high infestation area and 38% individuals in less infested area claimed that the weed has strong thorns when pierce the skin it causes skin itching and wound (36%). In non-infested area there was no awareness about impact of the weed therefore to slow down the fast spread awareness should be made among society.

Table 4. Respondents' perception on effect of *P. juliflora* on crop production, livestock Production and human health in East Shewa and West Arsi Zones, ONRGS

Effect on Animal, Crop production and Human Health	High infestation N=40		Less infested N=40		No infestation		Total N=40	
	n	%	n	%	n	%	n	%
Effect on crop Production(Roots makes difficult to Plough).	27	68	3	8	0	0	30	25
Displace Grass Spps.	35	88	12	30	0	0	47	39
Effect on Animal Production and health.	20	50	11	28	0	0	31	26
Effect on Human Health (Wound and Itching)	28	70	15	38	0	0	43	36

N= sample size of each category n= Frequency

3.2.4 Economic benefits of *P. juliflora*

The socio economic survey identified the uses of *P. juliflora* in both highly and less infested areas this includes shade, fence, fire wood and house construction (Table5).

Table 5. Respondents' perception on economic benefits of *P. juliflora* in East Shewa and West Arsi Zones, ONRGS

Economic benefits of prosopis	High infestation N=40		Less infestation N=40		No infestation N=40		Total	
	n	%	n	%	n	%	n	%
Shade	30	75	3	8	0	0	33	28
Fence	26	65	7	18	0	0	33	28
Fire Wood/Charcoal	24	60	1	3	0	0	25	21
House construction	32	58	1	3	0	0	33	28

N= sample size of each category n= Frequency

The use of the plant for shade was the first most frequently mentioned benefit of *P. juliflora* in the study sites (Table 5). According to 75% of respondents in high infestation areas the *P. juliflora* is the plant species which grows well in desert areas with an evergreen leaves and stems under moisture stressed conditions and it became an important shade during the last five years in improving the microclimate in the study area. This indicated that the weed is seems beneficial during its early introduction therefore to manage further spread of the plant, it should be replaced by indigenous plant which can resist arid condition. *P. juliflora* also used for fence (65%) and house (60%) construction. However most of pastoralist and agro pastoralist need proper control action. This is in agreement with Shetie (2008) report which indicated that the plant is very important for live and dead fencing around the villages and farm lands.

REFERENCES

Abdillahi A., Aboud, P., Kisoyan, K. and Coppock, D.L. (2005). Agro-Pastoralists' Wrath for the *P. juliflora* Tree: The Case of the II Chamus of Baringo District. Pastoralrisk Management project, Kenya.

Hailu, S., Demel, T., Sileshi, N. and Fassil, A. 2004. Some biological characteristics that foster the invasion of Prosopis juliflora (Sw.) DC. at Middle Awash Rift Valley Area, north-eastern Ethiopia. *Journal of Arid Environments,* 58 (2004) 135 -154.

Kassahun, Z. 1999. Mesquite (*Prosopis juliflora*) in Ethiopia. *Arem* ,5:14-26.

Kassahun, Z., Yohannes, L. and Olani, N. 2004. *Prosopis juliflora*: Potentials and Problems. *Arem* 6: 1-10.

Martin, B.W and Foxcroft, L.C. 2002. Atlas of maps for invasive alien species with in the Kruger National Park. p44

Mwangi, E.and Shallow, B. (2005). Invasion of *P. juliflora* and local livelihoods: Case study from the lake Baringo area of Kenya. ICRAF working paper-No.3, WorldAgroforestry, Nairobi, Kenya.

Rezene, F.(2006). Challenges and potential of *P. juliflora*. pp. 53-63 In: *Alien invasive weed and insect pest*: Management and control option (Rezene Fessehaie, Aberra Tekelemariam, Kemal Ali Mohammed Dawd and Seid Ahemed, eds.). Second National Workshop on Alien Invasive Weeds and Insect Pest.

Senayit, R., Agajie, T., Taye, T., Adefires, W. and Getu, E. 2004. Invasive Alien Plant Control and Prevention in Ethiopia. Pilot Surveys and Control Baseline Conditions. Report submitted to EARO, Ethiopia and CABI under the PDF B phase of the UNEP GEF Project - Removing Barriers to Invasive Plant Management in Africa. EARO, Addis Ababa, Ethiopia.

Shetie, G., 2008. The Ecological Distribution and Socio-Economic impacts of *Prosopis juliflora* (Sw.) DC. in the Amibara Woreda, Afar National Regional State. An M.sc Thesis presented to School of graduate studies Addis Ababa University.

Taye, T., Ameha, T., Adefiris, W. and Getu, E. 2004d. Biological Impact Assessment on Selected IAS Plants on Native Species Biodiversity. Report submitted to EARO, Ethiopia and CABI under the PDF-B phase of the UNEP GEF Project - Removing Barriers to Invasive Plant Management in Africa. EARO, Addis Ababa, Ethiopia.

Wittenberg, R. (2004). Instruments and Tools for Assessing the Impact of Invasive Alien Plant Species in Africa. Report submitted under the PDF-B phase of the UNEP/GEF Project: Removing Barriers to Invasive Plant Management in Africa. CAB International Africa Regional Centre, Nairobi.