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**Diversity and Biomass Estimation of Tropical and Sub-Tropical Trees on  
Ashaavieen Nature Reserve, Msallata, Libya.****\* Ashokri, H.A**

**ABSTRACT:** This study was carried out to determine and to estimate the diversity and the biomass of tropical and sub-tropical trees in 50 study plots at Ashaavieen Nature Reserve, Msallata, Libya. The total number of trees recorded was 694 from 5 species of 5 families which are; Caesalpiniaceae, Mimosaceae, Oleaceae, Rhamnaceae, and Pinaceae. *Pinus halepensis* was the most dominant species with an Importance Value Index (IVI) of 66.64%. The total basal area (BA) recorded was at 6.58 m<sup>2</sup>/ha with *Pinus halepensis* representing the highest value at 6.21 m<sup>2</sup>/ha (94.37%). Shannon-Wiener Diversity Index (H') calculations have indicated low biodiversity in all study plots (H' < 1.5). Total biomass estimation was at 7904.39 t/ha with *Pinus halepensis* and *Ceratonia siliqua* contributions to the highest values respectively.

**Keywords:** Diversity, biomass estimation, tropical, sub-tropical, nature reserve, Msallata

**Introduction:**

Ecological studies of tropical and sub-tropical forests are crucial in order to monitor, manage, and conserve those ecosystems. Numerous researches have always confirmed that diversity loss has a negative impact on the eco-balance of any ecosystem (Symstad & Tilman 2001). Internationally, nature reserves represent about 1380 million ha (more than 8% of the size of earth) with a total number of more than 35,000 reserves. In the Arabian region alone, nature reserves approximately cover 38.5 million ha (2.8% of the total area of the Arabian region). About 44.4% of those reserves are located within the Arabian Gulf area and 28.3% are in Egypt, Sudan, Djibouti, and Somalia. While, 26.8% of those reserves are found in North Africa with about 11 nature reserves in the State of Libya and 0.5% in the eastern countries of the Mediterranean Sea (IUCN, 2010).

**Study area:**

Ashaavieen Nature Reserve is located in the western part of the State of Libya within the area of Ashaavieen forest (32.589128° N, 13.865004° E) about 20 km far to the Northwest of the city center of Msallata and about 90 km to the East of the Libyan capital of Tripoli. The total area of

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the reserve is about 469 ha (1158.92 acres). The reserve was first established as a forest project in the year of 1978, then it was officially recognized as a reserve in the year of 1998. The reserve is also distinguished by its high mountains, deep valleys, and dense plant cover (AOAD, 2008).

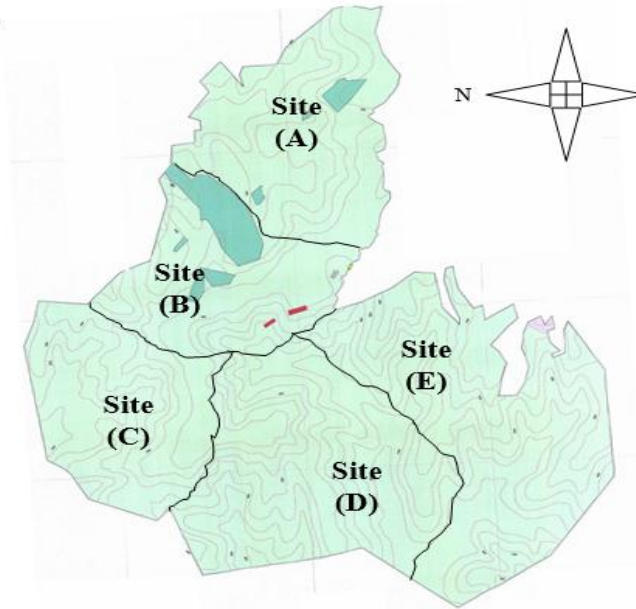


Figure 1: Study Area (Alhusein *et al.*, 2017).

### Methodology:

A total number of fifty study plots were established based on-site accessibility in August of 2019 at 5 sites; A, B, C, D, and E. Ten replicate plots each of 20 X 20 m were established at each site. The total size of the area sampled in each site was 0.4 ha (2 ha for all sites). All the trees with a DBH value  $> 10$  cm at breast height (1.3 m) were labeled, identified, and recorded for each site. Values of Basal Area (BA), Importance Value Index (IVI), Shannon-Wiener Index of diversity ( $H'$ ), and Total Biomass were also calculated (Lin *et al.*, 2017).

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**Results and Discussion:****Species distribution, DBH, BA, and IVI**

A total number of 694 individual trees from 5 species of 5 families were obtained in the whole area sampled (listed in table 1). Table 2 indicates that *Ceratonia siliqua* was present in sites; B, C, D, and E. *Acacia cyanophylla* was only present in site B. Yet, *Olea europaea* was only observed in two sites (A and B). The species of *Ziziphus lotus* has occurred in sites; C, D, and E. Meanwhile, *Pinus halepensis* was only absent in site D. An average DBH of 22.77 cm for *Pinus halepensis* scored the highest whilst, *Ziziphus lotus* recorded the lowest at 10.93 cm. As highlighted by Clough (1992) Ashaavieen Nature Reserve is considered as a threatened area and emergent actions have to be immediately taken as the total basal area attained for each species was less than 30 m<sup>2</sup>/ha as most individuals are considered juvenile and only a few of them are adults due to the wildfire incidents taking place in the years of 2005, 2013, and 2016. Furthermore, the total basal area for the whole area sampled was at 6.58 m<sup>2</sup>/ha with *Pinus halepensis* contributing the highest value at 6.21 m<sup>2</sup>/ha (due to species largeness) and *Olea europaea* contributing the lowest at 0.03 m<sup>2</sup>/ha. Table 1 also shows that *Pinus halepensis* is the most dominant species with an Importance Value Index of 66.64% with similar findings obtained by Rached-Kanouni *et al*, (2020) at 32.63%. However, *Olea europaea* was the less dominant species with an IVI of 4.88%. As reported by Curtis and McIntosh (1951), Ashaavieen Nature Reserve is considered as a zone of *Pinus halepensis*, *Ceratonia siliqua*, and *Ziziphus lotus* as they have achieved an IVI value higher than 10%.

**Shannon-Wiener index of diversity (H')**

Table 2 outlines that all study sites have shown low diversity as all Shannon-Wiener Index values were > 1.5. Comparatively, diversity in site B was the highest at 1.33 followed by diversity in site C with a convergent value of 0.94, Contrariwise, site A has the lowest diversity at 0.23. Additionally, diversity in site E was approximately 0.30 times greater than diversity in site A.

**Table 1: Family, species, number of individuals, DBH, BA, and IVI.**

Family	Species	Σ num of individuals/2 ha	Average DBH (cm)	Basal Area (BA) (m <sup>2</sup> /ha)	Importance Value Index (IVI) %
Caesalpiniaceae	<i>Ceratonia siliqua</i>	036	18.23	0.23	11.77
Mimosaceae	<i>Acacia cyanophylla</i>	013	13.08	0.04	04.93
Oleaceae	<i>Olea europaea</i>	005	16.45	0.03	04.88
Rhamnaceae	<i>Ziziphus lotus</i>	030	10.93	0.07	11.78
Pinaceae	<i>Pinus halepensis</i>	610	22.77	6.21	66.64
<b>Total</b>		<b>694</b>		<b>6.58</b>	<b>100%</b>

**Total Biomass:**

The total biomass estimated for Ashaavien Nature Reserve is considered large at 7904.39 t ha<sup>-1</sup>. Nevertheless, *Pinus halepensis* afforded the highest biomass value at 7888.27 t ha<sup>-1</sup> due to superiority besides the fact that most individuals of species were mature followed by *Ceratonia siliqua* at 252.29 t ha<sup>-1</sup>. On the other hand, the lowest biomass contribution was at 26.86 t ha<sup>-1</sup> for *Olea europaea* as it has the lowest number of individuals of 5 trees present only in sites; A and B. The total biomass calculations brought to light that sites; A and B scored the highest values at 3535.32 t ha<sup>-1</sup> and 3463.80 t ha<sup>-1</sup> respectively due to the obvious existence of *Pinus halepensis* with no significant difference ( $P > 0.05$ ). Moreover, site D has recorded the lowest biomass value at 49.40 t ha<sup>-1</sup> as the presence of *Pinus halepensis* was not recorded only for this site due to the sandy soil texture as stated by Alhusein et al, (2017). Statistical calculations elucidated that the difference in total biomass between sites; A and D was not significant ( $P > 0.05$ ) as well as to sites; B and D.

**Table 2: Species, Shannon-Wiener Index (H'), and total biomass.**

Species	Shannon-Wiener index (H')					Total Biomass (t/ha)				
	A	B	C	D	E	A	B	C	D	E
<i>C. siliqua</i>	-	0.09	0.29	0.36	0.35	-	56.06	42.05	35.04	119.14
A. <i>cyanophylla</i>	-	0.14	-	-	-	-	38.32	-	-	-
<i>O. europaea</i>	0.04	0.30	-	-	-	16.12	10.74	-	-	-
<i>Z. lotus</i>	-	-	0.34	0.29	0.32	-	-	18.29	14.36	21.95
<i>P. halepensis</i>	0.19	0.80	0.31	-	0.02	3519.20	3358.68	271.65	-	382.79
<b>Total</b>	<b>0.23</b>	<b>1.33</b>	<b>0.94</b>	<b>0.65</b>	<b>0.69</b>	<b>3535.32</b>	<b>3463.80</b>	<b>331.99</b>	<b>49.40</b>	<b>523.88</b>
<b>Total Biomass</b>						<b>7904.39</b>				

**Conclusion:**

This study concludes that the total number of trees found in all sites was at 694 from 5 species of 5 families. *P. halepensis* scored the highest values of Importance Value Index, DBH, and basal area at 66.64%, 22.77 cm, and 6.21 m<sup>2</sup>/ha respectively. Diversity index from largest to smallest is B > C > E > D > A sequentially. The total estimated biomass was at 7904.39 t ha<sup>-1</sup>.

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تقدير التنوع الحيوي والكتلة الحيوية لبعض الأشجار الاستوائية وشبه الاستوائية بمحمية الشعافيين الطبيعية، مسالطة، ليبيا

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**المستخلص:** أجريت هذه الدراسة لتحديد وتقدير التنوع الحيوي والكتلة الحيوية لمجموعة من الأشجار الاستوائية وشبه الاستوائية في 50 قطعة دراسية بمحمية الشعافيين الطبيعية، مسالطة، ليبيا. إجمالي عدد الأشجار المسجلة كان 694 شجرة من 5 أنواع تنتمي لـ 5 فصائل هي: الفصيلة السيزلبينية، الميموزية، الزيتونية، الرمنية، والفصيلة الصنوبرية. كان الصنوبر الحلبي *Pinus halepensis* أكثر الأنواع سيادة حيث بلغ مؤشر قيمة الأهمية (IVI) ما نسبته 66.64%. وبلغ إجمالي المساحة القاعدية المسجلة (BA) ما قيمته 6.58 متر<sup>2</sup>/هكتار مع تسجيل الصنوبر الحلبي *Pinus halepensis* لأعلى قيمة عند 6.21 متر<sup>2</sup>/هكتار أو ما نسبته (94.37%). أشارت حسابات مؤشر شانون وينر للتنوع الحيوي (H') إلى انخفاض التنوع البيولوجي في جميع القطع الدراسية حيث كانت قيمته أقل من 1.5. كان إجمالي الكتلة الحيوية المقدرة 7904.39 طن/هكتار مع مساهمة الصنوبر الحلبي *Pinus halepensis* و *Ceratonia siliqua* بأعلى القيم على التوالي.

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